An investigation of nonverbal imitation and language in children with specific language delay

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Abstract

Children with specific deficits in language do not form a homogeneous group, but present with varied profiles of language skills and deficits. Research in children with language problems has focussed on deficits in the acquisition of lexical forms and syntactic structures of language, but our understanding of children's deficits with the meaning of language remains limited.

Sociocognitive abilities are necessary for discovering the meaning of language, and it has been hypothesised that some children with specific deficits in language have sociocognitive difficulties. In this thesis, it is argued that nonverbal imitation, which does not involve the processing of structural aspects of language, may be indicative of sociocognitive difficulties. More specifically, it is argued that types of nonverbal imitation which serve a primarily *social function* are more informative about sociocognitive abilities than types of nonverbal imitation which serve a primarily *instrumental function*.

In line with this reasoning, it has been found that *different* forms of nonverbal imitation can be separately impaired and associated with different language skills in children with autism spectrum disorder (ASD), who are known to have sociocognitive difficulties. However, there has been very little exploration of nonverbal imitation skills in children with specific deficits in language, and existing studies have predominantly involved school-age children.

This study set out to investigate elicited immediate nonverbal imitation as a measure of sociocognitive skills in young typically developing (TD) children and children with specific language delay (SLD), and also to investigate relations between performance on nonverbal imitation and language in the SLD sample. A subsidiary aim was to compare the performance of the TD and SLD samples on verbal imitation.

Participants were German-speaking TD (n=60) and SLD (n=45) children aged 2-3½ years, who were divided into three age groups (2;0-2;5, 2;6-2;11, 3;0-3;5 years). A novel battery of tasks measured their attempt and ability to imitate a range of nonverbal (body movements, common instrumental acts on objects, pretend acts) and verbal (words, nonwords, sentences) target acts.

It was found that groups with SLD performed significantly below TD groups on some, but importantly not all, nonverbal imitation tasks. Results demonstrated that children with SLD did not have a general difficulty with nonverbal imitation, but a specific difficulty with target acts hypothesised to serve a primarily social function. A comparison of types and rates of nonverbal imitation errors revealed that error patterns in the oldest SLD group resembled those in the youngest TD group, suggesting a delay rather than deviance in some types of nonverbal imitation within the SLD sample. Different relations between performance on nonverbal imitation and language emerged at different ages, pointing towards the possibility that the nature of associations between nonverbal imitation and language might be linked to age and change over time. As expected, results revealed verbal imitation deficits in the SLD sample at all ages. The theoretical and clinical implications of findings are discussed.

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Abbreviations

A:	Arbitrary
ASD:	Autism Spectrum Disorder
BAS II:	British Ability Scales Second Edition II
Bayley II:	Bayley Scales of Infant Development II
C:	Common
CA:	Chronological age
CELF-R:	Clinical Evaluation of Language Fundamentals - Revised
DCD:	Developmental Coordination Disorder
ERB:	Early Repetition Battery
ET 6-6:	Entwicklungstest 6 Monate-6 Jahre
F:	Familiar
IB:	Imitation Battery
ISI:	Intention-sensitive nonverbal imitation
LB:	Late Bloomers
LI:	Language Impairment
LM:	Language-matched
LT:	Late Talkers
MCDI:	MacArthur Communicative Developmental Inventory
M-CHAT:	Modified Checklist for Autism in Toddlers
MIS:	Motor Imitation Scale
MN:	Mirror neurons
Movement ABC:	Movement Assessment Battery for Children
Mullen Scales:	Mullen Scales of Early Learning
NVMA:	Nonverbal mental age
OSI:	Outcome-sensitive nonverbal imitation

PDD-NOS:	Pervasive Developmental Disorder-not otherwise specified
PDSS:	Patholinguistische Diagnostik bei Sprachentwicklungsstörungen
Peabody:	Peabody Picture Vocabulary Scale-Revised
PLI:	Pragmatic Language Impairment
PLS:	Preschool Language Scale
PSRep:	Preschool Repetition Test
Reynell	Reynell Developmental Language Scales
SCQ:	Social Communication Questionnaire
SD:	Standard deviation
SETK-2:	Sprachentwicklungstest für zweijährige Kinder
SETK-3:	Sprachentwicklungstest für drei- bis fünfjährige Kinder
SIT:	Sentence Imitation Test
SLD:	Specific Language Delay
SLI:	Specific Language Impairment
SLT:	Speech and Language Therapist
SON-R 2 1/2:	Snijders-Oomen Non-verbaler Intelligenztest
SPSS:	Statistical Package for the Social Sciences
TD:	Typical Development
U7:	U-Untersuchungen (Kindervorsorgeuntersuchungen)
UF:	Unfamiliar
VA:	Verbal age
WPPSI:	Wechsler Preschool and Primary Scale of Intelligence
YC:	Younger control

1 Introduction

Children with specific deficits in language do not form a homogeneous group, but present with varied profiles of language skills and deficits (Leonard, 1998). It is known that some children have primary problems with the forms and structures of language, some have problems with the meaning and social use of language and some have problems in both areas (Bishop, 1998). Research in children with language problems has focussed on deficits in the acquisition of lexical forms and syntactic structures of language. This is exemplified by research on verbal imitation such as word, nonword and sentence repetition as indicators of phonological and morphosyntactic constraints (Conti-Ramsden, Botting, & Faragher, 2001; Graf Estes, Evans, & Else-Quest, 2007). In contrast, our understanding of children's deficits with the meaning of language remains limited.

Sociocognitive abilities are necessary for discovering the meaning of language, and it has been hypothesised that some children with specific deficits in language have sociocognitive difficulties (Chiat, 2001). In this thesis, it is argued that nonverbal imitation, which does not involve the processing of structural aspects of language, may be indicative of sociocognitive difficulties. More specifically, it is argued that types of nonverbal imitation which serve a primarily *social function* are more informative about sociocognitive abilities than types of nonverbal imitation which serve a primarily *instrumental function*. In line with this reasoning, it has been found that *different* forms of nonverbal imitation can be separately impaired and associated with different language skills in children with ASD, who are known to have sociocognitive difficulties (Rogers & Williams, 2006). However, there has been very little exploration of nonverbal imitation skills in children with specific deficits in language, and existing studies have predominantly involved school-age children. Based on these arguments, this study set out first to investigate nonverbal imitation as a measure of sociocognitive skills in 2;0-3;5-year-old children with specific language delay (SLD), and second to investigate relations between performance on nonverbal imitation and language. Such investigation has the potential to throw new light on the nature of children's early language problems and to add to our understanding of the heterogeneity of children with SLD.

The first section of this chapter introduces the notion of nonverbal imitation and explains why nonverbal imitation is assumed to provide a window onto children's cognitive processing skills. Sections 1.2 and 1.3 review and evaluate literature on nonverbal imitation in children with ASD and children with atypical language development. Theoretical analyses of nonverbal imitation together with empirical evidence from these studies provide the rationale for investigating nonverbal imitation as evidence of sociocognitive capacities in children with SLD (section 1.4). Section 1.5 considers the criteria for identifying children with SLD and section 1.6 considers the selection of nonverbal imitation measures. Section 1.7 provides the rationale for an in depth analyses of children's nonverbal imitation errors patterns and for interpreting selective non-compliance as evidence of difficulty rather than uncooperativeness. Finally, section 1.8 gives the reasons why children in this study were also assessed on a range of verbal imitation tasks, in addition to the main battery of nonverbal imitation tasks.

1.1 Nonverbal imitation

1.1.1 Categorisation and terminology

In this thesis, a distinction will be made between the phenomenon of nonverbal *imitation* and the phenomenon of nonverbal *mimicry*, which can both be categorised under the term nonverbal copying (Figure 1). The term *copying* is an umbrella term and assembles a range of different types of matching behaviours. It is generally accepted that copying 'is a natural mechanism that involves perception and action coupling for mapping one's own behavior onto the behavior observed in others' (Decety, 2006, p. 252).

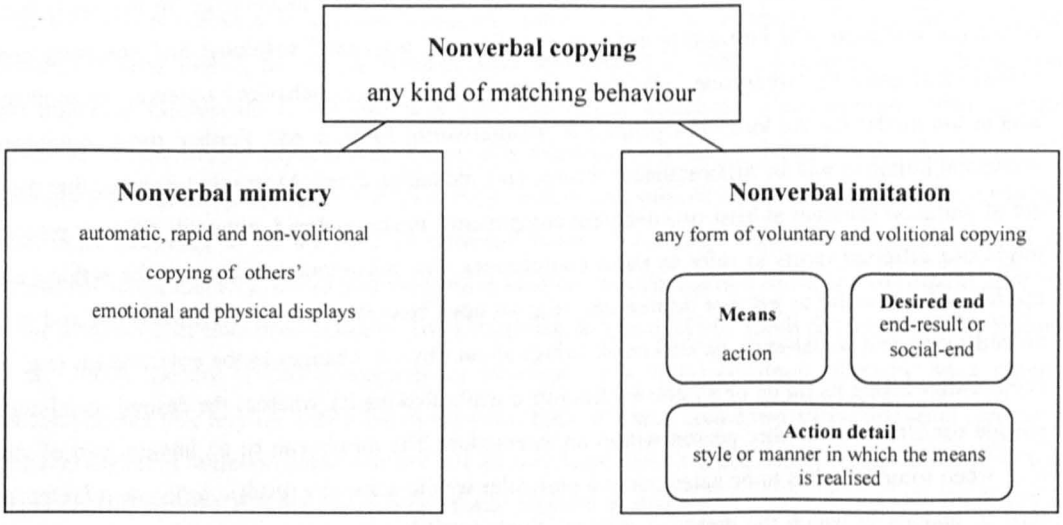

Figure 1: Categorisation of nonverbal mimicry and imitation

NONVERBAL MIMICRY

The term *mimicry* is usually as well as in this thesis used to refer to an automatic, rapid and non-volitional copying behaviour that is acted out neither with conscious planning or control nor with explicit behavioural intentions or goals (Chartrand & Bargh, 1999; Moody & McIntosh, 2006; Rogers, 2006; Tomasello & Carpenter, 2005). It is the precise and synchronous copying of others' emotional and physical displays and involves in particular simple body postures, facial expressions and emotionally salient stimuli like yawning or social smiling. Byrne (2005) differentiates the phenomena of learning by copying (or imitation) and social mirroring (or mimicry) with regard to their diverse developmental functions: whereas learning by copying serves the purpose of acquiring new skills, social mirroring has the function of establishing a form of mutual identification and empathy between interaction partners. Chartrand and Bargh (1999) refer to this sense of connectedness or 'being in tune with another person' as the 'chameleon effect'; and showed that adult participants automatically mimicked the motor behaviour of strangers with whom they worked and that this unconscious mimicry of postures increased the linking between interaction partners. According to Tomasello, Kruger and Ratner (1993), mimicry is a reproduction of behaviour in a technical sense but does not lead to the acquisition of new behaviour and is

thus not a form of social learning. However, the questions whether and how mimicry may underpin early social and emotional development (Moody & McIntosh, 2006), as well as whether the phenomenon of neonatal copying of simple facial movements within the first weeks of life (Meltzoff & Moore, 1977, 1997) should be classified as mimicry or imitation, are still the subject of debate in the literature (Butterworth, 1999; Rogers, 2006).

NONVERBAL IMITATION

Nonverbal imitation has become the focus of interest across different disciplines. The term imitation has therefore been used to cover divergent concepts that range from broad perspectives on imitation - where imitation refers to various matching behaviours - to much more restricted perspectives on imitation - where imitation refers only to cases in which individuals copy body movements. In this study the term *nonverbal imitation* will be used to refer to any form of nonverbal volitional and voluntary copying behaviour (Figure 1), 'when one individual voluntarily reproduces behaviour observed in another who acts as the model for the form of a behaviour' (Butterworth, 1999, p. 65). Further, three components of nonverbal imitation will be differentiated: means, end and action detail. Most scholars agree that the basic act of imitation involves at least two different components, means and end, although different researchers might use different terms to refer to these components. The behavioural *means* are the action (e.g. the uplifting of a box-lid) to get to a desired *end* (e.g. an open box) (Bratman, 1989), where the end is either an end-result or a social-end. An end-result brings about obvious changes in the environment (e.g. a box is open after lifting its lid up or a rattle evokes noise while shaking it), whereas the desired social-end is to engage socially with another person within an interaction. The means can be an integral part of the end (e.g. when something has to be acted out in a particular way to achieve a result). *Action detail* refers to the style or manner in which the means is realised. Such detail is not necessary to achieve an end, i.e. does not influence the outcome of an imitative act (e.g. the pushing of a button will evoke an effect regardless of the way in which the button has been pressed).

1.1.2 The cognitive and neural bases of nonverbal imitation

To date there is no consensus in the literature about cognitive and neural correlates serving imitation behaviour. The following sections consider one frequently discussed - but not generally accepted - perspective on the cognitive and neural basis of imitation in which mirror neurons (MN) might play an important role.

NONVERBAL IMITATION BEHAVIOUR AS A MOLAR CONSTRUCT

At the core, imitation is the ability to map representations of perceived actions to representations of the same action in the existing behavioural repertoire (Williams, Whiten, Waiter, Pechey, & Perrett, 2007). It has been supposed that this essential cognitive and neural perception-action matching mechanism underpins and is common to different forms of simple to complex imitation (Decety, 2006; Williams, Waiter, Gilchrist, Perrett, Murray, & Whiten, 2006; Williams et al., 2007). However, although necessary, this matching mechanism is not sufficient even for simple imitation, which requires other cognitive functions. Which specific capacities are necessarily required for imitation depend on the characteristics of different forms of Imitation behaviours, i.e. their content and complexity. A wide range of competencies have been described to be involved in different forms of imitation behaviour, e.g. perceptional and attentional skills, memory, motor planning and execution, monitoring and correction of responses, as well as the attribution of intentions (Decety, 2006; Hepburn & Stone, 2006; Smith & Bryson, 1994; Williams et al., 2007). Decety (2006) conceptualises imitation as a molar construct, drawing on a range of subcomponents that rely on a distributed network. Each of these connected subcomponents computes a different aspect of imitation behaviour and not all subcomponents are necessarily required for all forms of imitation. Importantly, it is the *integration* of subcomponents that enables the function of imitation. Thus, imitation is the result of a large network involving many different loci that integrates brain activity between areas serving different cognitive functions (Williams et al., 2007).

MIRROR NEURONS – THE CORE NEURAL SUBSTRATE OF IMITATION?

MN are a particular class of visuomotor neurons that were first discovered in the ventral premotor cortex area F5 and the inferior parietal lobule of macaque monkeys brains in the mid 90s (Di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996; see Rizzolatti & Craighero, 2004; Rizzolatti, Fabbri-Destro, & Cattaneo, 2009 for reviews). These cells have the characteristic that they are activated by both the active execution and the passive perception of the same goal-directed action (e.g. grasping an object) indicating that perception and execution of an action activate some common neural substrate.

As perception-action matching has been supposed to be the core process of imitation behaviour, it has been proposed that MN might serve an imitation function as an important neural substrate, not only in monkeys but also in humans (Iacoboni, 2009; Rizzolatti, Fadiga, Fogassi, & Gallese, 2002; Williams et al., 2007). However, to date it remains controversial *if* a MN system in humans exists which closely resembles that found in monkeys in terms of brain areas and functions (Turella, Pierno, Tubaldi, & Castiello, 2009). It is further under debate what the *explicit* role of the MN system would be in an imitation function in humans (Fan, Decety, Yang, Liu, & Cheng, 2010; Williams et al., 2006) if indeed it

exists. The first empirical results show that the MN system alone does not represent a brain structure dedicated to the function of imitation. Rather MNs are more likely to be embedded within clusters of neural components with imitation-specific activity (Williams et al., 2007). This is in line with the conceptualisation of imitation behaviour as a molar construct (Decety, 2006).

1.1.3 Developmental functions of nonverbal imitation

Imitation - in contrast to mimicry - is a form of *social learning* (Bandura, 1989). In terms of developmental value, at least two main functions of imitation for children's development can be differentiated: an instrumental and a social function (Carpenter & Call, 2007).

The *instrumental function* of imitation has also been labelled as a means of learning that focuses on the cognitive-intrapersonal components of imitation and the child as imitator (Masur, 2006; Meltzoff, 2005; Nadel, Guérini, Pezé, & Rivet, 1999; Uzgiris, 1981). Children imitate events or the use of objects to acquire new skills and behaviours that help to solve problems in their physical world (Carpenter & Call, 2007; Nielsen, Suddendorf, & Dissanayake, 2006; Uzgiris, 1981). Immature individuals imitate the way experts use instruments and behave in events to learn about properties of artefacts and tools in the environment as well as customs and rituals of their culture (Bransford et al., 2006; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009; Tomasello et al., 1993). Imitative learning therefore serves the purpose of transmitting cultural behaviour and information within and across generations. It is faster and more effective than working out causal relations by oneself and less dangerous than trial-and-error learning.

Imitation normally takes place in social interactions. The *social function* of imitation has also been referred to as a means of communication (Nadel et al., 1999) that emphasises the social-interpersonal components of imitation (Masur, 2006; Meltzoff, 2005; Uzgiris, 1981). The social function of imitation serves the purpose of engaging socially with others in coordinated activities to share the experience of mutuality and understanding. According to Carpenter and Call (2007), the imitation of the demonstrator is in this case the means to get to the desired social-end of experiencing socio-emotional engagement in an interaction. Imitation in interactions also enables the practice and development of social communicative strategies such as interpersonal timing and shared attention to the same topic through the alternation of imitating and being imitated (Nadel & Peze, 1993; Nadel et al., 1999; Trevarthen, Kokkinaki, & Fiamenghi Jr, 1999; Uzgiris, 1981). Imitative behaviour is hypothesised to establish a sense of early connectedness (Meltzoff & Gopnik, 1993) and to be the foundation for the development of intentional communication (Nadel & Peze, 1993).

The instrumental and the social function are closely interlinked as instrumental learning mostly takes place in social interactions. The function of an imitative behaviour is in addition dependent on the particular interactional and environmental context where it takes place.

1.1.4 Nonverbal imitation as a sociocognitive skill

Importantly, 'children do not slavishly duplicate what they see but re-enact a person's goals and intentions. [...] [They] choose whom, when, and what to imitate and seamlessly mix imitation and self-discovery to solve novel problems' (Meltzoff et al., 2009, p. 285). That is, humans, even from infancy, filter events and certain components of these in a specific context (Nadel, 2006). It would make neither instrumental nor social sense for children to imitate everything in any context in everyday life. Instead, they select components that are purposeful and meaningful to them and the demonstrator at a particular moment and thus worth the effort of being imitated. Evidence for this is the finding that children filter out accidental actions and ignore irrelevant aspects of modelled acts (Carpenter, Akhtar, & Tomasello, 1998). They adapt their own actions along the way and come up with new or other already established behaviour if this is more useful in a certain situation (Carpenter, 2006; Carpenter & Call, 2007). For example, they often use their own means (e.g. turn a box upside down instead of lifting the lid) to duplicate the outcome of an observed behaviour (e.g. open a box). Further, if a demonstrator meant to do an action with an object but failed to complete it successfully, children successfully complete the target action themselves even if they have never seen the result (Meltzoff, 1995). Such selective imitative behaviour has the advantage of being creative, efficient and flexible to respond appropriately in different imitation contexts and with regard to different imitation contents.

But how do children know which aspects of an imitation act are accidental or what a demonstrator meant to do? To know what components are important to imitate and what aspects of others' actions can be neglected, children need to *interpret* a demonstrator's behaviour. That is, they have to see a situation from the perspective of the other person and to search for the purpose behind an action and the effect on the world that this person intended to generate (Carpenter, 2006; Tomasello & Carpenter, 2005; Tomasello et al., 1993). Since the purpose of an act is not always observable, it is not sufficient to simply rely on the observable surface aspects of behaviour. Instead, it is necessary to *infer* the goals and intentions *behind* actions and utterances. A range of observable information provides pragmatic cues or markers of intentionality which make it possible to read intentions and goals behind acts within their specific context. In other words, they help to detect what the other person is trying to do and what to imitate in events (Carpenter & Call, 2007) The range of pragmatic cues includes (Carpenter & Call, 2007; Tomasello & Carpenter, 2005):

- explicit deictic and/or verbal instruction from the demonstrator about what to imitate and/or how (e.g. 'take this' or 'twist the lid like I do');
- markers of satisfaction and dissatisfaction that indicate effort, failure or accidents like emotional facial expressions or verbal comments accompanying actions (e.g. 'Whoops!' versus 'There!') (Carpenter, Akhtar, et al., 1998);
- directive markers such as the direction of gaze, the timing of gaze shifts or pointed looks (Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998);

- information entailed in the situation or context such as the presence or absence of an observable result or what the demonstrator did prior to the presentation (Carpenter, Call, & Tomasello, 2002; Southgate, Chevallier, & Csibra, 2009); and
- an arbitrary behaviour, i.e. a behaviour that children experienced in a different way prior to the current event that can evoke a search for the relevance of the observed behaviour (e.g. why a light panel has been turned on by pressing the panel with the head rather than by hand) (Gergely, Bekkering, & Király, 2002; Schwier, van Maanen, Carpenter, & Tomasello, 2006).

Because of its crucial dependence on the ability to understand others' intentional states, imitation has been categorised under the umbrella of *sociocognitive skills* (Carpenter, Nagell, et al., 1998; Carpenter, Pennington, & Rogers, 2002), i.e. is a behaviour that relies significantly on sociocognitive capacities. Furthermore, imitation has been hypothesised to play a potential role in the building of social cognition. The developmental role of imitation as a mechanism of social cognition, especially for more elaborated forms of social cognition such as empathy and theory of mind, has become a focus of interest (Meltzoff, 2002; Nadel, 2006).

However, it is important to keep in mind that, although children volitionally filter what to imitate, this selection cannot be equated with a conscious, reflective or even meta-cognitive process. In addition, the role of intention-reading in imitation acts does not apply in the same way for different types of imitation, since nonverbal imitation behaviour is multifaceted and the nature of different imitation acts varies substantially. In the following, it will be specified why *some* forms of nonverbal imitation are assumed to rely more on sociocognitive capacities than others.

In section 1.1.2, it was pointed out that some forms of nonverbal imitation behaviour primarily serve the developmental function of solving instrumental problems, whereas others primarily serve the developmental function of engaging socially with the demonstrator. Most imitation acts serving an instrumental function come to an end-result that brings about changes in the environment (e.g. to evoke music by striking a xylophone), whereas imitation acts serving a social function come to a social-end of shared mutuality and understanding (e.g. to engage socially with another person by imitating body movements).

An *end-result* is an observable functional outcome. The most salient end-results are sensory effects. To reproduce such end-results, an imitator selects and extracts useful information from a demonstrated act (Whiten, Custance, Heyes, & Galef, 1996). In so doing, she/he primarily focuses on the object with which a demonstrator interacts rather than the demonstrator her/himself. Since the event is intrinsically biased towards an outcome, imitators learn about features and affordances of objects in the environment more than behavioural strategies (Tomasello & Carpenter, 2005; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). In the imitation literature, this type of imitative behaviour has been referred to as emulation (Wood, 1989). To date, terminology and definitions of emulation remain controversial and different researchers have taken emulation or similar terms to mean slightly different things (see Huang, Heyes, & Charman, 2002 for a review). Heyes & Ray (2002) refer to imitation acts that are primarily

guided by their physical instrumental and sensory outcomes as outcome-sensitive nonverbal imitation (OSI) and this term will be adopted in this thesis.

In contrast, a *social-end* is a socio-emotional engagement with the demonstrator to share an enjoyable experience of mutuality and understanding. Since social-ends are not observable functional outcomes, the demonstrator's intentions behind such actions are not obvious to the observer, but have to be inferred. For example, the imitation of body movements is a rather purposeless action. The main reason for children to reproduce such purposeless actions is to share a social reward-based fun experience with the demonstrator. Thus, imitation acts resulting in social-ends focus on the demonstrator as a person and her/his actions, and the intentions behind these actions. Cases in which individuals copy modelled body movements guided by attribution of goal and intention to the model have been referred to as true imitation, using the term imitation in a much more restricted sense than in this thesis (Tomasello et al., 1993; Want & Harris, 2002; Whiten et al., 2009). Because of its' focus on understanding the model's intention, Heyes & Ray (2002) refer to this type of imitation as intention-sensitive nonverbal imitation (ISI) and this term will be adopted in this thesis.

In this thesis it is assumed that intention-sensitive imitation draws more on sociocognitive capacities than outcome-sensitive imitation.

1.1.5 Nonverbal imitation as a method to assess cognitive processing

Studies designed to investigate TD children's abilities to reproduce modelled postures and gestures have revealed a number of characteristic and systematic imitation errors. For example, young children systematically reproduced demonstrations that involved contralateral movements (crossing the midline) as ipsilateral responses, and made significantly more errors when imitating unimanual than bimanual demonstrations or used their dominant hand when presented with unimanual demonstrations with their nondominant hand (Bekkering, Wohlschläger, & Gattis, 2000; Erjavec & Horne, 2008; Gleissner, Meltzoff, & Bekkering, 2000). The number of repeated trials did not improve children's response accuracy and 2-year-old children produced more imitative inaccuracies than 3-year-old children (Erjavec & Horne, 2008).

Based on these results, authors have argued that *elicited* reproduction of a modelled act is not a one-to-one mimicking but an active and creative reconstruction of an observed act. It is an *interpretation* of an event which depends on children's abilities to perceive, map and recode demonstrated stimuli. Hence, elicited imitation taps children's cognitive processing (Gleissner et al., 2000; Wagner, Yocom, & Greene-Havas, 2008), and children's errors to replicate modelled nonverbal contents provide a window onto how they process demonstrated information. Furthermore, the reproduction of *different* nonverbal target actions taps different cognitive functions and abilities such as peripheral visual perception and motor planning (see section 1.1.2).

In the previous section it was argued that nonverbal imitation, and especially ISI, draws on sociocognitive capacities (see section 1.1.4). This led to the hypothesis that the elicited reproduction of ISI behaviour will be an indicator of children's sociocognitive capacities. Conversely it was argued that OSI is less dependent of sociocognitive abilities, implying that the elicited reproduction of OSI behaviour will not be indicative of children's sociocognitive capacities. It follows from this that children known to have sociocognitive processing deficits should perform poorly on measures of ISI, whereas measures of OSI should be less challenging.

1.2 Research on nonverbal imitation in children with ASD

Autism is a pervasive developmental disorder that is characterised by a triad of deficits in social behaviour, communication and behavioural flexibility that all three need to be identified in an individual to be diagnosed as autistic (American Psychiatric Association, 2000). Nevertheless, there is considerable phenotype heterogeneity in this population which has led to the widely accepted view that a range of different autistic conditions, including classic autism, pervasive developmental disorder-not otherwise specified (PDD-NOS), atypical autism and Asperger's syndrome, exist in a spectrum of related disorders, forming autism spectrum disorder (ASD). Intellectual disability, deficits in language and deficits in imitation are among the key related features of the ASD phenotype, in addition to the core deficits listed above.

It is now well established that children with ASD, who are known to have social and communication deficits, show deficits in nonverbal imitation (Williams, Whiten, & Singh, 2004). This supports the hypothesis that elicited nonverbal imitation behaviour draws on sociocognitive abilities. However, it was also argued than nonverbal imitation behaviour is complex and multifaceted, with some types relying more on sociocognitive abilities than others (see section 1.1.4). This raises the question whether certain types of nonverbal imitation behaviour are more problematic for children with ASD and whether there is empirical evidence to support the hypothesis that measures of ISI behaviour will be more challenging than measures of OSI behaviour for children with sociocognitive deficits.

More recently, research attention has turned to this question, investigating which *specific forms of nonverbal imitation* characterise the profile of individuals with ASD (Rogers & Williams, 2006). It has been of particular interest whether different target acts (such as postures, gestures, instrumental and pretend acts) show selective impairment and are independently related to different developmental skills (such as joint attention, play, language) in individuals with ASD (e.g. Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; Charman, Swettenham, Baron-Cohen, Cox, Baird, & Drew, 1997; Rogers, Hepburn, Stackhouse, & Wehner, 2003; Stone & Yoder, 2001). A systematic review of this research was conducted in order to establish which types of nonverbal imitation have been found to be particularly difficult for children with ASD in comparison to TD peers. This will indicate whether, as hypothesised, these are measures of ISI rather than OSI, and whether the results for this group of children support the classification of imitation tasks according to this distinction.

1.2.1 Selection of studies

This research review and evaluation are based on research published in peer reviewed journals, identified through a computerised literature search for the period up to July 2011 of the data bases Web of Knowledge, Ebscohost, Ovid and Science Direct using a fixed set of key words (copy* or imit* or emulat* or mimic* AND child* or infant* or toddler* or preschool*AND autis* or Asperger* or autism spectrum disorder* or ASD). A manual search of core journals, articles and books was also conducted.

Studies investigating nonverbal imitation skills in children have been carried out in many different ways by researchers from multiple disciplines and backgrounds over several decades, using diverse study designs and methods. For example, studies have involved adults as well as children as *demonstrators*, looked from different *perspectives* on the imitative act (focussing on a person's ability to reproduce a modelled behaviour versus her/his reaction to being imitated), investigated different types of *imitation responses* (differentiating immediate versus deferred and spontaneous versus elicited responses), considered *measures* with specific as well as mixed imitative target acts, and involved *control groups* with children drawn from different populations (see below). The multidisciplinary nature of this research has yielded interesting multifaceted results but complicates a comparison of research outcomes due to the substantial variations in methodologies. Given the scale and heterogeneity of the research, this review focuses on studies that are most relevant to questions addressed in this investigation. Studies identified by the search above were constrained to investigations focussing on elicited immediate nonverbal imitation, in which demonstrations were modelled by an adult and at least presented to one clinical group of children/adolescents with ASD and one control group of TD children. The rationale for these constraints is given below:

1. As reported above, some studies have investigated *spontaneous* imitative responses, observing children's behaviour in naturalistic settings or by parental questionnaires, others have focussed on *elicited* imitative responses using directive measures to elicit specific imitation behaviours. Since the aim of this literature review was to evaluate whether *specific* types of nonverbal imitation have been found to be particularly difficult for children with ASD, it was necessary to evaluate performance on a range of nonverbal imitation behaviours. Therefore, the literature review will focus on research eliciting systematically controlled imitative responses, whereas results of studies targeting spontaneous responses are not considered (Dawson & Adams, 1984; Pry, Petersen, & Baghdadli, 2009). The focus on elicited responses further implies the exclusion of studies targeting children as demonstrators and children's reaction to being imitated (Nadel et al., 1999).

2. Directive measures of nonverbal imitative behaviour can be designed to elicit *immediate* responses, i.e. the imitator reproduces a modelled act immediately after the demonstration without deferral, or *deferred* responses, i.e. the imitator reproduces a modelled act after a temporal delay that can range from a couple of minutes to some weeks or even months. Measures of deferred imitation rely crucially on children's memory performance, whereas measures of immediate imitation are designed to minimise the impact of memory capacities on the imitation performance. Since the literature review was conducted to evaluate the hypothesis that measures of ISI might be indicators of

children's sociocognitive constraints, and performance on deferred measures of ISI is likely to be considerably influenced by children's memory capacities, results of studies targeting deferred imitative responses were not included (Rogers, Young, Cook, Giolzetti, & Ozonoff, 2008).

3. Measures with *mixed* nonverbal imitative target acts that yielded one composite score were excluded (e.g. Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Sigman & Ungerer, 1984; Stone, Lemanek, Fishel, Fernandez, & Altemeier, 1990), since the evaluation set out to compare performance on specific types of nonverbal imitation.
4. Studies that incorporated no control group (Green, Baird, Barnett, Henderson, Huber, & Henderson, 2002) or no control group that exclusively comprised TD children, (e.g. Charman & Baron-Cohen, 1994; Hammes & Langdell, 1981; Rogers, Bennetto, McEvoy, & Pennington, 1996; Rogers, Young, Cook, Giolzetti, & Ozonoff, 2010), were excluded, since the evaluation set out to compare performance of children with ASD and TD peers.
5. Further, inclusion of two individual investigations was given further consideration: Stieglitz Ham et al. (2011) investigated performance on gesture imitation and instrumental acts on objects. Analyses of gesture performance in this study were included in the evaluation (see Table 2), whereas performance on instrumental acts was not, due to different conditions for the demonstrator and the imitator (the demonstrator modelled the act *with* real objects, but the child had to reproduce the act *without* having access to objects). Beadle-Brown and Whiten (2004) investigated performance on nine different categories of target acts. Unfortunately, it was not possible to retrace without doubt which conditions involved which items and which conditions were found to significantly differentiate groups. Therefore results of comparisons between specific measures will not be considered for this review. However, an analysis of children's error patterns across conditions will be reported elsewhere in this introduction.

1.2.2 Measures of nonverbal imitation: Classification and terminology

As pointed out in the previous section, studies investigating nonverbal imitation in children have been carried out by researchers from multiple disciplines and backgrounds. In addition to multifaceted study designs, this has resulted in substantially differing terminology which complicates the communication of research outcomes. To communicate patterns of outcomes comprehensively and coherently, measures of nonverbal imitation are therefore distinguished and reported using *consistent* classifications and terminology in this study, sometimes changing classifications and terminology used in original studies. However, it should be kept in mind that due to methodological differences the comparability of studies is limited and comparisons have to be interpreted with caution.

Different nonverbal imitation tasks will be classified and labelled according to the type of content embedded within them. In total, four different types of nonverbal target tasks have been administered: the imitation of postures, gestures, instrumental acts on objects and pretend acts. Furthermore, the different types of nonverbal target acts will be categorised as measures of ISI or OSI.

MEASURES OF ISI

Intention-sensitive target acts focus on the demonstrator and her/his body actions without coming to a salient instrumental end-result. Since the imitation of postures and gestures does not involve objects but requires the reproduction of body movements guided by attribution of goal and intention to the model, posture and gesture tasks have been categorised as ISI (see section 1.1.4). Measures of ISI are assumed to be relatively reliant on sociocognitive capacities.

Postures

Posture tasks model movements of one or more parts of the body (e.g. lift both arms, pull one earlobe) that do not convey conventional or symbolic meaning and can only be described in terms of changes in posture and location (Vivanti, Nadig, Ozonoff, & Rogers, 2008; Williams et al., 2004). They can involve different parts of the body, e.g. parts of the face (facial postures), one or both hands (manual postures), or hand movements towards different locations of the body (hand to body postures).

Postures have also been designated by terms such as 'nonmeaningful/meaningless gestures' (Stieglitz Ham et al., 2011; Vivanti et al., 2008), 'body/manual/oral-facial movements' (McDuffie, Yoder, & Stone, 2005; Rogers et al., 2003; Stone, Ousley, & Littleford, 1997), 'body imitation' (Ingersoll & Meyer, 2011) and 'gestures' (Aldridge, Stone, Sweeney, & Bower, 2000; Ohta, 1987).

Representational gestures

According to Crais, Watson and Baranek (2009), presenting the work of Iverson and Thal (1998), 'gestures are actions produced with the intent to communicate and are typically expressed using the fingers, hands, and arms, but can also include facial features (e.g. lip smacking for 'eating') and body motions (e.g. bouncing for 'horsie') [...]' (p.96). Iverson and Thal (1998) differentiate between deictic and representational gestures. Whereas deictic gestures (e.g. pointing, reaching) are exclusively used to guide a person's attention to an object or event (i.e. to establish reference to a desired object or event), representational gestures establish reference *and* indicate a particular fixed semantic content that does not vary across contexts (e.g. flapping hands for 'bird' or waving 'good bye'). Within the category of representational gestures, a further distinction is made between *object related gestures* and *conventional gestures*. Object related gestures represent characteristic features of the referent object and its use and act as substitutes for actions on objects (e.g. pretend to drink from a bottle by representing the shape of a bottle and a drinking action). Conventional gestures (e.g. shaking head for 'no') have a culturally defined social-communicative function and represent an abstract concept.

Object related gestures have also been designated as 'pantomime' (Smith & Bryson, 2007; Stieglitz Ham et al., 2011) and communicative gestures as 'conventional' (Smith & Bryson, 2007) and 'intransitive' gestures (Stieglitz Ham et al., 2011).

MEASURES OF OSI

Outcome-sensitive target acts focus on the salient functional end-result of an action on an object rather than the demonstrator her/himself and *necessarily* involve objects. Since instrumental acts on objects involve objects and focus on the physical and observable outcome of an act rather than the demonstrator, they are categorised as OSI (see section 1.1.4). Measures of OSI are assumed to be relatively independent of sociocognitive capacities.

Instrumental acts

Instrumental acts are actions on objects whose function it is to cause a certain result (e.g. striking a xylophone will evoke noise or music). To achieve an outcome, an object and its properties have to be manipulated according to a particular strategy. Instrumental acts on objects can involve familiar or unfamiliar objects as well as common and arbitrary acts.

Familiar objects are everyday objects and toys that children most likely will have seen and experienced before in their everyday life, so they are aware of the object's function and (at least approximately) know how to manipulate which properties to cause the outcome.

Unfamiliar objects are objects that children have never seen or played with before so they are unaware of their function, i.e. they need to learn about properties and/or particular strategies that are necessary to reproduce results of modelled instrumental acts. It is important to emphasise that, while *specific* causal links between object-properties, particular action strategies and results, are new for children in the case of unfamiliar objects, the *general* action strategies required (e.g. pressing buttons, shaking objects etc.) are assumed to be already present in children's behavioural repertoires.

Further, instrumental acts on familiar as well as unfamiliar objects can be characterised as *common acts*, i.e. events similar to those that children have most likely experienced before in their everyday life, or as *arbitrary acts*, i.e. events that children have most likely not experienced with these objects before. Consequently, four different task categories for instrumental acts on objects are possible: 1) common acts with familiar objects (e.g. push a button to start a police car), 2) common acts with unfamiliar objects (e.g. shake a new toy to evoke a squeaking noise), 3) arbitrary acts with familiar toys (e.g. push a bathing plastic toy with the forehead to evoke a squeaking noise) and 4) arbitrary acts with unfamiliar objects (e.g. touch the panel of an unknown box with the forehead to switch on a light).

Not all studies have distinguished different categories of instrumental acts. Instrumental acts have been termed as 'actions on objects' (Rogers et al., 2003) and 'object imitation' (Charman et al., 1997). Instrumental acts on unfamiliar objects have been labelled 'actions on novel objects' (Toth, Munson, Meltzoff, & Dawson, 2006), and common versus arbitrary acts have been referred to as 'meaningful versus nonmeaningful' (McDuffie et al., 2005; Wu, Chiang, & Hou, 2011) and 'instrumental versus arbitrary' (Carpenter, Pennington, et al., 2002) actions on objects.

HYBRID MEASURES

Imitation tasks that model pretend acts focus on three different types of tasks: acts involving *appropriate objects*, acts involving *neutral substitute objects* and acts involving *counterfunctional substitute objects*. Single acts or sequences with appropriate objects require the use of objects according to their original everyday function and context, even when they are miniaturised versions of objects (e.g. pretend to feed a teddy-bear with a toy spoon). Pretend acts with substitute objects require the decontextualized use of neutral or counterfunctional objects, dealing with objects as if they were something else; neutral objects have no clear function (e.g. the use of a wooden block as a cup) whereas counterfunctional objects are items associated with clear functions and used to represent something with a different function (e.g. the use of a pencil as a toothbrush).

Like OSI, pretend acts with substitute objects involve real objects. However, like ISI, they do not lead to an unambiguous functional outcome, since objects are used in decontextualised or even counterfunctional acts which do not produce a singular instrumental result (e.g. pretend to use a pencil as toothbrush). Therefore, the imitator has to focus on the actions of a demonstrator to be able to reproduce a modelled act. Because there is no clear instrumental function, children have to infer *why* a demonstrator intends to perform and engage in such an odd action, i.e. that it is fun and informative to pretend to deal with objects as if they were something else. Accordingly, pretend acts do not fall clearly into the ISI and OSI categories, and will be referred to as hybrid measures.

Pretend acts with substitute objects have been referred to as 'unconventional actions with objects' (Smith & Bryson, 2007) and 'pretend play' (Libby, Powell, Messer, & Jordan, 1997).

1.2.3 Specific deficits in nonverbal imitation

Table 1 provides an overview of studies that compared groups of children with ASD and TD on their ability to imitate specific nonverbal behaviours. It gives information about authors, age and number of participants, criteria for matching clinical and control group(s), specific targets of nonverbal imitation measures and outcomes of statistical comparisons.

MEASURES OF ISI

Studies that focussed on *preschool-age* children's ability to imitate **facial and body postures** reveal a mixed picture. Aldridge et al. (2000) found that all children with ASD uniformly scored zero on a task that required the imitation of facial and body postures and Rogers et al. (2003) found that children with ASD scored significantly below TD children on a task that targeted the imitation of facial postures. In contrast, Rogers et al. found no difference between children's ability to imitate body postures and Wu et al. (2011) did not find group differences between a group of TD children and a group of children with ASD on the imitation of facial and body postures. The pattern is clearer in terms of *school-age* children's ability to imitate postures since the five studies identified consistently found that children with ASD performed below TD children on this task (Jones & Prior, 1985; Ohta, 1987; Smith & Bryson, 1998; Stieglitz Ham, Corley, Rajendran, Carletta, & Swanson, 2008; Vivanti et al., 2008).

No study looked at *preschool-age* children's ability to imitate **representational gestures**, but three studies investigated gesture imitation in *school-age* children. Of these studies, two found significantly better performance in the TD group in comparison to the ASD group (Smith & Bryson, 2007; Stieglitz Ham et al., 2011), but one revealed the opposite picture (Libby et al., 1997). However, since the difference between the chronological age of clinical and typical groups in Libby et al.'s study was substantial (TD: 26-31 months; ASD: 64-200 months), results can hardly be compared to outcomes in the two other studies in which the chronological age of groups overlapped (Smith & Bryson: TD: 3;4-13;7 years; ASD: 7-18;5 years) or groups were matched on chronological age (Stieglitz Ham et al.). A task presenting conventional gestures significantly differentiated typical and clinical groups in Stieglitz Ham et al.'s study, but was not group-sensitive in Smith and Bryson's study.

MEASURES OF OSI

Rogers et al. (2003) and Wu et al. (2011) both looked at children's skills in imitating *arbitrary* **instrumental acts with familiar objects** and consistently found that the TD group performed significantly better than the ASD group. In contrast, no significant group difference was revealed by Wu et al. when presenting *common* instrumental acts with familiar objects.

Only one study compared typical and clinical groups on their ability to imitate **instrumental acts with unfamiliar objects**, using a measure that involved *common as well as arbitrary* instrumental acts (Charman et al., 1997). It was found that children with ASD performed significantly below their TD peers on this task.

HYBRID MEASURES

Smith and Bryson (2007) and (Libby et al., 1997) compared a group of older children with ASD to a group of younger TD children on their ability to imitate different types of **pretend acts**. The former study found significantly better performance in the TD (3;4-13;7 years) than the ASD (7-18;5 years) group whereas the latter found significantly better performance in the substantially older ASD (64-200 months) than TD (26-31 months) group. Since children in the ASD group were at least three times older than TD children in Libby et al.'s study, these different outcomes are very likely to be influenced by children's chronological age.

EVALUATION

The review of research on a range of nonverbal imitation acts relevant to this study revealed that some nonverbal tasks differentiated ASD and TD groups more consistently than others, and in addition more consistently at certain age ranges.

Measures of ISI

There is convincing evidence that *school-age* children with ASD aged 6;3-18;5 years have deficits in imitating **postures** (Jones & Prior, 1985; Ohta, 1987; Smith & Bryson, 2007; Stieglitz Ham et al., 2011; Vivanti et al., 2008), but results for *preschool-age* children with ASD aged 26-52 months were less in agreement, with differences found by Aldridge et al. (2000) and Rogers et al. (2003; facial postures) but not by Wu et al. (2011) and Rogers et al. (2003; body postures). Hence, it is possible that the chronological age of children with ASD has an impact on their performance on measures of posture

imitation. However, since results of studies with preschool-age children are variable, it has to be questioned what might be the reason for these inconsistencies at the preschool-age level. Comparing characteristics of ASD and TD groups between studies reveals inconsistencies in how clinical and control groups were matched on language and nonverbal cognitive skills. For example, clinical and control groups were matched on verbal age in Wu et al.'s study, but the TD group had better language skills than the ASD group in Rogers et al.'s study. Since Wu et al. found *no* significant group difference on the imitation of facial postures whereas Rogers et al. *did*, it might be inferred that children's imitation performance is related to their language skills. However, since the TD group in Wu et al.'s study had also a lower nonverbal mental age than the ASD group whereas clinical and control groups were matched on nonverbal mental age in Rogers et al. study, it might just as well be inferred that children's imitation performance is related to their nonverbal cognitive skills. This example highlights that inconsistencies in results might be linked to how clinical and typical groups were matched on developmental factors such as language and nonverbal IQ. But since studies vary in more than one parameter, it is impossible to trace differences in results to a single factor.

Looking at children's ability to imitate **representational gestures**, three out of four analyses showed that groups of school-age children with ASD performed more poorly than TD groups on object related and conventional gestures (significant: Smith & Bryson, 2007 [object related gestures]; Stieglitz Ham et al., 2011; not significant: Smith & Bryson [conventional gestures]).

Overall, and in line with theoretical expectations, these empirical findings suggest that children with ASD have difficulty with measures of ISI.

Measures of OSI

In contrast to theoretical expectations, three out of four investigations revealed deficits in the imitation of instrumental acts (Charman et al., 1997; Rogers et al., 2003; Wu et al., 2011). Given that instrumental acts were not assumed to draw crucially on social cognition, it has to be considered why these tasks were challenging for children with ASD. Interestingly, all measures that significantly differentiated typical and clinical groups involved *arbitrary* target acts, whereas the one that did not involved *common* instrumental acts (significant: Charman et al.; Wu et al. [arbitrary acts]; Rogers et al.; not significant: Wu et al. [common acts]). Arbitrary, in contrast to common acts, require children to search for the relevance of an observed behaviour. In other words, children have to find out *why* they should imitate an odd behaviour when they could stick to an already experienced alternative (e.g. to turn on a light panel with the hand rather than by head), which requires an interpretation of an observed demonstration. Arguably, then, *arbitrary* instrumental acts are less pure measures of OSI since they are likely to require some sociocognitive capacities. However, since *common* instrumental acts were only presented in one study (Wu et al.), conclusions must be cautious, even though, in line with theoretical expectations, no significant differences were found between groups on this measure of OSI.

In general, there is considerable evidence for the assumption that children with ASD, who are known to have difficulty with sociocognitive abilities, perform more poorly than their TD peers on measures that are hypothesised to require sociocognitive capacities (postures, gestures, arbitrary instrumental acts, pretend acts with substitute objects), but results are not entirely consistent. Having considered how studies were designed, it becomes clear that inconsistencies in results might be related to differences in the design of studies. Most notably, inconsistencies in outcomes might be due to differences in the chronological age of ASD groups, since results were more consistent for school-age than for preschool-age children; and to language and nonverbal cognitive skills of the TD control groups, since results suggest differences according to nonverbal IQ and language. However, because studies contrast on too many different parameters it is impossible to determine effects of a single factor, such as language ability, from comparisons of different studies. To gain a more in depth picture of whether and how nonverbal imitation might be related to language, the next section evaluates outcomes of studies looking at the relation between performance on different measures of nonverbal imitation and different measures of language in children with ASD.

Table 1: Overview of studies comparing performance of TD and ASD groups on specific nonverbal imitation behaviours

Author & date	Age & number	Matching criteria ASD & TD groups	Specific target of nonverbal imitation task											
			Postures (ISI)		Gestures (ISI)		Instrumental acts (OSI)				Pretend acts (Hybrid)			
			facial	body	object related	conven-tional	familiar object		unfamiliar object		appro-priate object	substitute object		
												neutral	counter-functional	
							C	A	C	A				
PRESCHOOL-AGE														
Charman et al., 1997	ASD: 20.7 months (n=10) TD: 20.3 months (n=19)	matched on CA; TD group had sig. higher language skills and NVMA							p<.001					
Aldridge et al., 2000	ASD: 26-50 months (n=10) TD: 5-22 months (n=10)	matched on object concept task (not standardised); TD group had (much) lower CA; no clear info. about language skills	qualitative analyses showed clear group difference (ASD participants scored zero)											
Rogers et al., 2003	ASD: 26-41 months (n=24) TD: 18-24 months (n=15)	matched on NVMA; TD group had sig. lower CA and sig. higher language skills	p<.01 facial	ns body				p<.01						
Wu et al., 2011	ASD: 26-52 months (n=18) TD: 20-26 months (n=19)	matched on VA; TD group had sig. lower CA and NWMA	ns	ns			ns	p<.05						
SCHOOL-AGE														
Jones & Prior, 1985	ASD: 8;7 years (n=10) TD CA: 8;7 years (n=10) TD MA: 3;4-4;6 years (n = 10)	TD CA: matched on CA TD MA: matched on NVMA		Task 1: p<.001 Task 2: p<.01 (TD CA & MA)										
Ohta, 1987	ASD: 6;3-14;4 years (n=16) TD: 3-6 years (n=189)	no matching criteria (only info.: 'TD children showed no overt retardation or behaviour abnormalities')		p<.05 (3;5-4;0 years TD only)										
Libby et al., 1997	**ASD: 64-200 months** (n=10) TD: 26-31 months (n=10)	matched on VA; substantial CA difference between groups			(p<.05) ASD better!						(ns)	(p<.05) ASD better!	(p<.05) ASD group better!	
Smith & Bryson, 1998, 2007	ASD: 7-18;5 years (n=20) TD: 3;4-13;7 years (n=20)	matched on VA; TD group had lower CA		p<.01	p<.001	ns							p<.05	
Vivanti et al., 2008	ASD: 11;5 years (n=18) TD: 11;0 years (n=13)	matched on CA and VA		p<.01										
Stieglitz Ham et al., 2008, 2011	ASD: 7-15 years (n=19) TD: 7-15 years (n=23)	matched on CA and VA		p<.001	p<.001	p<.001								

C= common, A = arbitrary; CA = chronological age, VA = verbal age, NVMA = nonverbal mental age

1.2.4 Relation between nonverbal imitation and language

The key word search and selection criteria for inclusion of studies investigating the relation between nonverbal imitation and language in children with ASD were almost identical to those used with the previous literature search (see section 1.2.1). Only the specification 'AND language' was added to the set of key words. The selection criteria differed in that the focus was on relations to language skills and no control group was required. Investigations assessing preverbal pragmatic rather than language skills were excluded (e.g. Abrahamsen & Mitchell, 1990; Curcio, 1978). Hence, all investigations that were selected for the literature review included one group of participants who, without exception, were diagnosed with ASD. Every participant was assessed on at least one task of elicited immediate imitation and one general or specific language measure.

Table 2 gives an overview of the selected studies investigating *relations* between nonverbal imitation and language skills in children with ASD, providing details about authors, number and age of participants, specific targets of nonverbal imitation measures, language assessments, and outcomes in terms of concurrent and longitudinal relations between imitation and language scores. The majority of studies recruited participants of preschool-age, but one also assessed school-age children. Studies presented in Table 2 are compacted in Table 3, allowing the reader to see at a glance how *selective* nonverbal imitation skills relate to concurrent and later *receptive* and/or *expressive* language in different studies.

OVERALL LANGUAGE

Two studies (Carpenter, Pennington, & Rogers, 2001; Wu et al., 2011) looked at relations between an overall language score, an average of the receptive and expressive subscales of the Mullen Scales of Early Learning (Mullen Scales) (Mullen, 1997), and different nonverbal imitation targets (postures, instrumental acts). All relations between nonverbal imitation and general language skills were found to be non-significant.

Relation to expressive language

Expressive language has most frequently been the focus of analyses of relations between language and nonverbal imitation. Altogether nine analyses investigated *concurrent* and *longitudinal* relations between nonverbal imitation and expressive language.

Measures of ISI

Five studies analysed relations between children's ability to imitate **postures** and their expressive language skills. In terms of relations to *concurrent* expressive language skills, as many studies found significant correlations (Ingersoll & Meyer, 2011; Stone et al., 1997) as did not (Rogers et al., 2003; Wu et al., 2011). Looking at relations between nonverbal imitation and *later* expressive language skills, all investigations found these to be significant (McDuffie et al., 2005; Stone et al., 1997), with one revealing posture imitation as a unique longitudinal predictor of expressive vocabulary over and above cognitive delay and commenting (McDuffie et al., 2005).

Measures of OSI

Almost all investigations analysing relations between children's imitation of **instrumental acts with familiar objects** and their concurrent or later expressive language skills found non-significant associations, whether the instrumental acts were categorised as common or arbitrary (Ingersoll & Meyer, 2011; McDuffie et al., 2005; Rogers et al., 2003; Wu et al., 2011). However, Ingersoll and Meyer (2011) found a significant relation between a measure of mixed common and arbitrary instrumental acts with familiar objects and concurrent expressive language skills, but only *before* and not *after* controlling for cognitive delay.

The picture is less clear when comparing results of studies that looked at relations between **instrumental acts on unfamiliar objects** and expressive language abilities. Toth et al. (2006) found a significant correlation between a measure of mixed common and arbitrary instrumental acts on unfamiliar objects and *concurrent* expressive language skills, and (Carpenter, Pennington, et al., 2002) found that *arbitrary but not common* instrumental acts on unfamiliar objects were associated with *concurrent* expressive language skills. In contrast, Charman et al. (2003) found no significant correlation between a measure of mixed common and arbitrary instrumental acts on unfamiliar objects and *later* expressive language skills. Thus, arbitrary instrumental acts were included in the two investigations yielding significant associations with expressive language (Carpenter, Pennington, et al., 2002; Toth et al., 2006), but also in the one that did not (Charman et al., 2003).

RELATION TO RECEPTIVE LANGUAGE

A smaller number of studies, four in total, analysed associations between nonverbal imitative skills and receptive language.

One study reported a significant relation between the imitation of postures, a **measure of ISI**, and later receptive language skills *before - but not after -* controlling for cognitive delay and commenting (McDuffie et al., 2005).

Three studies reported instrumental acts, characterised as **measures of OSI**, which combined common and arbitrary instrumental acts. No significant relations were found between the imitation of instrumental acts on *familiar* objects and later receptive language skills (McDuffie et al., 2005), whereas relations between the imitation of instrumental acts on *unfamiliar* objects and concurrent and longitudinal receptive language skills emerged as significant in the two other studies (Charman et al., 2003; Toth et al., 2006).

Smith and Bryson (2007) analysed associations between children's ability to imitate **pretend acts** on counterfunctional substitute objects and receptive language abilities and found a significant correlation between these skills. Pretend acts with substitute objects were categorised as hybrid between a measure of ISI and OSI.

EVALUATION

This overview not only shows that there are significant relations between nonverbal imitation and language skills in children with ASD, but more importantly, that outcomes are influenced by the specific nature of the imitation acts and the language skills investigated.

All relations between nonverbal imitation and **language composites** were found to be non-significant, indicating that analyses between nonverbal imitation and *specific* language skills are more revealing than analyses between nonverbal imitation and *overall* language measures.

Measures of ISI

Studies revealed relations between the imitation of **postures** and receptive and expressive language abilities, though not consistently. No study was found that looked at the relation between **gesture** imitation and language. To evaluate possible reasons for inconsistencies in outcomes, it was considered which *specific* language skills were investigated and how these were measured. Looking at differences in relations between *posture* imitation and receptive versus expressive language skills, the relation to *receptive* language was found to be significant (McDuffie et al., 2005), whereas the relation to *expressive* language was more variable (significant: Ingersoll & Meyer (2011); Stone et al. (1997); non-significant: Wu et al. (2011); Rogers et al. (2003)). However, since only one study investigated the relation between posture imitation and receptive language, generalisation is hardly possible. Looking at differences in relations between *posture* imitation and concurrent versus later receptive and expressive language skills, *longitudinal* relations between posture imitation and language skills consistently emerged as significant (McDuffie et al.; Stone et al.), whereas relations between posture imitation and *concurrent* language skills revealed a mixed pattern (significant: Ingersoll & Meyer; Stone et al.; non-significant: Wu et al.; Rogers et al.). Evaluating which specific *language measures* were administered in which study revealed that studies identifying *significant* relations between the imitation of postures and language used the MacArthur Communicative Developmental Inventory (MCDI) (Fenson et al., 1993), whereas studies yielding *non-significant* relations used the Mullen Scales, whether focussing on receptive or expressive or concurrent or later language (MCDI: Ingersoll & Meyer; McDuffie et al.; Stone et al.; Mullen Scales: Wu et al.; Rogers et al.).

Overall, these findings highlight the possibility that the nature of the relation between posture imitation and receptive versus expressive and concurrent versus later language skills might be specific, and furthermore, that different language measures designed for different purposes might yield slightly different language profiles.

Measures of OSI

All studies investigating relations between the imitation of **instrumental acts with familiar objects** and receptive and expressive language found *non-significant* associations, whether focussing on common or arbitrary acts or on receptive or expressive or concurrent or later language skills (Ingersoll & Meyer, 2011; McDuffie et al., 2005; Rogers et al., 2003; Wu et al., 2011).

In contrast, results revealed a diverse picture for the relation between the imitation of **instrumental acts on unfamiliar objects** and receptive and expressive language skills (Carpenter, Pennington, et al., 2002; Charman et al., 2003; Toth et al., 2006). Comparing results is problematic, since studies focussed on different parameters (e.g. common versus arbitrary acts or receptive versus expressive language) and accordingly used different measures of imitation and language and in different combinations. Looking at differences in the relation between the imitation of instrumental acts on unfamiliar objects and receptive

versus expressive language, the two studies considering *receptive* language both found significant associations (Charman et al.; Toth et al.), whereas the studies considering *expressive* language found significant as well as non-significant associations (significant: Carpenter, Pennington, et al. [arbitrary]; Toth et al.; non-significant: Carpenter, Pennington, et al. [common]; Charman et al.). Looking at the possible impact of common versus arbitrary acts, it was found that measures including *arbitrary* acts almost consistently yielded significant associations to language (Carpenter, Pennington, et al. [arbitrary]; Toth et al.; Charman et al. [receptive but not expressive language]), whereas a measure of 'pure' *common* acts yielded non-significant associations to language (Carpenter, Pennington, et al. [common]).

In the last section it was reported that children with ASD, in comparison to TD peers, had more difficulty imitating instrumental acts on *arbitrary* than *common* instrumental acts and it was argued that this difficulty was related to the fact that the imitation of *arbitrary* acts relies on sociocognitive capacities, whereas the imitation of *common* acts does not. Following this argument, it might be concluded that performance on imitative acts hypothesised to rely on sociocognitive capacities is revealing about language skills, whereas performance on imitative acts hypothesised to be relatively independent of sociocognitive capacities is not. However, given that the majority of studies presenting *familiar* objects found non-significant associations to language, whereas the majority of studies presenting *unfamiliar* objects found significant associations, differences in outcomes might just as well be related to whether objects were familiar or unfamiliar rather than whether acts were common or arbitrary. In the light of this, it has to be questioned what differentiates instrumental acts with familiar versus unfamiliar objects, since there is no reason to suggest that acts with familiar versus unfamiliar objects rely more or less crucially on sociocognitive capacities. More likely, the replication of instrumental acts with unfamiliar objects may impose an additional strain on children's general cognitive load, as it requires processing of new and inexperienced information. From this it would follow that performance on imitative acts that are more demanding of general processing capacities is more revealing about language skills than performance on imitative acts demanding less of general cognitive capacities.

Overall, this evaluation highlights that the specific nature of imitation acts and language skills, and the way these are measured, might have an impact on the relation between nonverbal imitation and language in children with ASD. Analyses between nonverbal imitation and *specific* language skills were found to be more informative than analyses between nonverbal imitation and *overall* language measures, and language measures should be selected carefully to yield informative language profiles. Outcomes also emphasised the need for precisely designed measures to elicit the imitation of instrumental acts, controlling for parameters such as common versus arbitrary acts as well as familiar versus unfamiliar objects. However, despite the multifaceted and inconsistent methodology of different studies, relations between the imitation of postures, arbitrary instrumental acts on unfamiliar objects and pretend acts and *receptive* language emerged as almost consistent. Hence, the relation between those measures that are hypothesised to rely on sociocognitive capacities and receptive language emerged as almost consistent in children who are known to have social and communication deficits, whereas the relation to expressive language was more variable.

Table 2: Overview of studies investigating relations between nonverbal imitation and language in children with ASD

Author & date	Sample: number & CA	Target of nonverbal imitation task(s)	Outcome & language measures
PRESCHOOL-AGE			
Stone et al., 1997 Study 2	n=26 Time 1: 23-35 months Time 2: 37-54 months (follow up at least 11 months after initial assessment)	• **body postures** • measure: Body Movements Scale of MIS	→ **concurrent & longitudinal** • imitation sig. correlated with **expressive vocabulary** at T1 (r=.49*) and T2 (r=.43*) • expressive vocabulary T1 & T2: MCDI
Carpenter et al., 2001	n=11 40-57 months	• common & arbitrary **instrumental acts on unfamiliar objects** • measure: task based on Meltzoff (1995)	→ **concurrent** • no sig. correlation between imitation & language • overall language: average of subscales expressive & receptive language of Mullen Scales
Carpenter, Pennington et al., 2002	n=12 Mean age: 48.8 months	• common & arbitrary **instrumental acts on unfamiliar objects** • measure: boxes to elicit instrumental & arbitrary actions with objects (Carpenter, Nagell et al., 1998)	→ **concurrent** • **arbitrary** (r=.67*) **but not conventional instrumental action** sig. correlated with **expressive language** • expressive vocabulary: number of spontaneous produced non-echoed referential words, coded during one session
Charman et al., 2003	n=18 Age Time 1: 20 months Age Time 2: 42 months	• common & arbitrary **instrumental acts on unfamiliar objects** • measure: task based on Meltzoff (1988a, 1988b)	→ **longitudinal** • imitation scores at T1 sig. associated (p<.05) with **receptive but not expressive language** at T2 • expressive and receptive language at T2: Reynell
Rogers et al., 2003	n= 29 Age: 26-41 months	• **facial postures; body postures** • arbitrary **instrumental acts on familiar objects** • measure: IB ; *separate* scores for different contents	→ **concurrent** • **no sig. partial-correlation** between scores of **any** imitation subscale and expressive language **after controlling for cognitive delay** • expressive language: expressive Mullen Scales
McDuffie et al., 2005	n=29 Age Time 1: 24-46 months Time 2: approx. 6 months later	• **body postures** • arbitrary & common **instrumental acts on familiar objects** • measure: MIS; *separate* scores for scales Actions with objects and Body movements	→ **longitudinally** • sig. correlation between **posture imitation (T1) and expressive** (r=.59**) **& receptive** (r=.38*) **language (T2);** posture imitation (T1) sig. predictor of expressive – but not receptive - vocabulary (T2) over and above cognitive delay & commenting • no sig. relation between instrumental acts & language • receptive & expressive vocabulary T2: MCDI

Table continued overleaf

Author & date	Sample: number & CA	Target of nonverbal imitation task(s)	Outcome & language measures
Toth et al., 2006	n=60 Time 1: 34-52 months Followed until: 65-78 months	• common & arbitrary **instrumental acts on unfamiliar objects** • measure: task based on Meltzoff (1988a, 1988b)	→ **concurrent** • imitative scores (T1) sig. associated with **receptive and expressive language** (T1) (r=.64**& r=.64**) • receptive & expressive language T1: both language Mullen Scales
Wu et al., 2011	n=18 Age: 26-52 months	• **facial postures; manual postures** • arbitrary & common **instrumental acts on familiar objects** (separate subtests) • measure: adapted IB; *composite & separate scores*	→ **concurrent** • no sig. correlation between any imitative subtask or composite and general or expressive language • overall language: average of both language Mullen Scales • expressive language: expressive Mullen Scales
Ingersoll & Meyer, 2011	n=27 Age: 22-47 months	• **body postures** • common & arbitrary **instrumental acts on familiar objects** • measure: MIS; *separate* scores for scales Actions with objects and body movements	→ **concurrent** • **correlation**: both separate imitation scores correlated with both **expressive language tasks** (r=.48-.58**) • **partial-correlations** controlling for cognitive delay: no sig. correlation between any imitation and language scores • expressive vocabulary: MCDI; expressive language: PLS
SCHOOL-AGE			
Smith & Bryson, 1998, 2007	n= 20 Age: 7-18.5 years	• **pretend acts** on counterfunctional substitute objects	→ **concurrent** • group of children categorised as *consistent imitators* (i.e. correctly imitated all pretend acts) scored sig. higher on receptive language than group of children categorised as *inconsistent imitators* *** (i.e. used some objects in their conventional way) • receptive language: Peabody

IB= Imitation Battery (Rogers et al., 2003), MCDI= MacArthur Communicative Developmental Inventory (Fenson et al., 1993), MIS= Motor Imitation Scale (Stone et al., 1997), Mullen Scales= Mullen Scales of Early Learning (Mullen, 1997), Peabody= Peabody Picture Vocabulary Scale-Revised (Dunn & Dunn, 1981), Reynell= Reynell Developmental Language Scales (Reynell, 1985), PLS= Preschool Language Scale (Zimmermann, Steiner, & Pond, 2002); CA = chronological age

Table 3: Compact overview of studies investigating relations between nonverbal imitation and language in children with ASD (C=common; A=arbitrary; F=familiar; UF=unfamiliar)

Author & date	Target of imitation task							Relation to language				
	Postures	Gestures	Instrumental acts				Pretend acts with substitutes	Receptive language		Expressive language		Overall language
			Familiar		Unfamiliar			Concurrent	Longitudinal	Concurrent	Longitudinal	Concurrent
			C	A	C	A						
Stone et al., 1997	X									**r=.49*** postures	**r=.43*** postures	
Carpenter et al., 2001					X							**r=ns** UF (C&A) instrumental
Carpenter, Pennington et al., 2002					X	X				**r=ns** UF(C) instrumental; **r=.67*** UF(A) instrumental		
Charman et al., 2003					X				**p<.05** UF (C & A) instrumental		**p=ns** UF (C & A) instrumental	
Rogers et al., 2003	X			X						**r (patial)=ns** postures & F(A) instrumental		
McDuffie et al., 2005	X		X						r=.38* **R²=ns** postures; **r=ns** F instru-mental		r=.59** **R²=.16**** postures; **r=ns** F instru-mental	
Toth et al., 2006					X			**r=.64**/R²=.38**** UF (C & A) instrumental		**r=.64**/R²=.37**** UF(C & A) instrumental		
Ingersoll & Meyer, 2011	X		X							**r =.48-.58**** postures & F (C & A) instrumental; **r (partial) = ns** all tasks		
Wu et al., 2011	X		X	X						**r = ns** postures & F (C) & F (A) instrumental		**r = ns** all tasks
Smith & Bryson, 1998, 2007							X	**p<.001** pretend				

1.3 Research on nonverbal imitation in children with atypical language development

A review of studies in children with ASD provided considerable empirical evidence for the assumption that the elicited immediate imitation of intention-sensitive behaviour is an indicator of children's sociocognitive capacities. Furthermore, it revealed significant relations between children's performance on nonverbal imitation measures that were hypothesised to rely on sociocognitive capacities and language skills. Interestingly, the nature of these relations was selective, since relations between measures of ISI and *receptive* language skills were found to be more consistent than relations between measures of ISI and *expressive* language skills. Given this empirical evidence of children with ASD, the question was raised whether measures of ISI would also be indicators of sociocognitive constraints in children with specific deficits in language who were not diagnosed with ASD, but of whom some are expected to have sociocognitive deficits (Chiat, 2001), and whether and how the nonverbal imitation performance of these children would be significantly related to their language skills. To answer this question, a further literature search was conducted to identify studies that compared nonverbal imitation performance in groups of children with atypical language development and typical language development and investigated relations between nonverbal imitation and language in these children.

Atypical language development is used as an umbrella term to describe children whose language development is below the average range for chronological age, without specifying the cause, nature or prognosis of the language deficit. It covers all terms that have been used by different researchers who have investigated the relation between nonverbal imitation and language to refer to clinical participants with language problems. The term language impairment (LI) is used to describe children whose language development is substantially below age level. It does not specify if the significant deficit in language ability occurs for no apparent reason or in the context of a neurological, sensory or physical impairment that directly affects use of spoken language. In contrast, the term specific language impairment (SLI) is frequently associated with children above the age of 4 years who have a persistent deficit specific to language without a concomitant developmental disorder (Bishop, 1997; Rescorla & Lee, 2000; Rice, Tomblin, Hoffman, Richman, & Marquis, 2004). The terms specific language delay (SLD) and late talkers (LT) are commonly used to refer to very young children identified with slow language development who are considered to be at risk of persistent language deficits (see section 1.5).

As in the previous section, the literature search was based on research published in peer reviewed journals, identified through a computerised literature search for the period up to July 2011 of the databases Web of Knowledge, Ebscohost, Ovid and Science direct using a fixed set of key words (copy* or imit* or emulat* or mimic* AND child* or infant* or toddler* or preschool*AND language delay* or late talk* or LT or specific language impair* or SLI or language impair*). A manual search of core journals, articles and books was also conducted. Studies identified by the search were constrained to investigations that assessed a group of participants diagnosed with atypical language development on at least one immediate elicited imitation task modelled by an adult. The same selection criteria applied for the literature research of studies in children with ASD and atypical language development.

Five studies were identified that fitted the criteria. They investigated different nonverbal imitative skills in children with LI (Smith & Bryson, 1998, 2007), school-age children with SLI (Hill, 1998; Hill, Bishop, & Nimmo-Smith, 1998; Marton, 2009; Vukovic, Vukovic, & Stojanovik, 2010), and LTs (Thal & Bates, 1988; Thal, Tobias, & Morrison, 1991). Results of a previous unpublished study with children with SLD (Dohmen, 2007) will also be considered. Table 4 provides information about all identified studies, including authors, number and age of participants, matching criteria of groups, specific targets of nonverbal imitation measures, language assessments, and outcomes.

MEASURES OF ISI

Five studies compared the performance of children with atypical language development and children with typical language development on posture and gesture imitation tasks. In four cases, investigations revealed that groups of children with atypical language development performed significantly poorer than age-matched TD groups on the imitation of postures (Marton, 2009; Vukovic et al., 2010), object related and conventional gestures (Hill, 1998) and a mix of postures and gestures (Dohmen, 2007). In Dohmen's investigation, significant differences between TD and SLD groups were found at the age of 30-34 months but not 37-47 months reflecting a significant increase in scores from 2-3 years in the clinical but not in the typical group. In two cases, no significant differences were found between the performance of typical and clinical groups on the imitation of postures (Hill, 1998; Smith & Bryson, 1998) and object related and conventional gestures (Smith & Bryson, 2007). Hill attributes the non-significant difference to ceiling effects in *all* clinical and control groups, i.e. the unexpected outcome of this comparison might be influenced by the construction of the posture imitation measure. Turning to Smith and Bryson's study, it is important to note that clinical and control groups were not age-matched, but that older participants with LI (6;10-17;8 years) were matched on receptive language skills to younger TD participants (3;4-13;7 years). Accordingly, clinical and control groups were matched differently than in all investigations that yielded significant group differences and it is likely that the divergent outcome of this particular investigation is linked to the divergent study-design. As for empirical results in children with ASD, this implies that imitation performance might be influenced by children's language skills and/or chronological age. Further support for this conclusion is provided by Hill's investigation. Her study design not only included a SLI group (mean age 9;9 years) and an age-matched TD group (mean age 9;8 years), but another control group of *younger* TD children (mean age 5;8 years). As reported above, significant differences were found between the SLI and age-matched TD groups on two gesture imitation tasks. However, this significant difference was not found in a comparison of the SLI and the *younger* TD groups on the same tasks, suggesting that the chronological age of children had an impact on their performance on measures of gesture imitation.

Collectively, results reported in this section suggest that children with atypical language development in comparison to aged-matched TD peers have difficulty imitating postures and gestures that were categorised as intention-sensitive.

Only one study investigated relations between posture imitation and language skills in children with atypical language development. This study reported a concurrent predictive relation between scores on a simple and complex posture imitation task and *expressive* vocabulary and between a simple - but not a complex – posture imitation task and *receptive* language skills in a group of Serbian-speaking school-age children with SLI (Vukovic et al., 2010; see Table 4).

MEASURES OF OSI

No investigation has targeted the ability of children with atypical language development to imitate instrumental acts on objects, either familiar or unfamiliar.

HYBRID MEASURES

Although more studies have investigated nonverbal imitation skills in children with ASD than in children with atypical language development, the specific skill of imitating pretend acts has been investigated more often in children with atypical language development. Thal and Bates (1988) compared a group of 18-32-month-old LT and groups of age-matched as well as younger language-matched TD participants on two different types of pretend acts tasks: the imitation of single pretend acts with appropriate and substitute objects and the imitation of sequences of pretend acts with appropriate objects. They found that the group of LT performed significantly below the group of age-matched controls on the former but not the latter type of tasks. Questioning what differentiates the two tasks, it might be argued that the imitation of *appropriate* pretend acts relies less on sociocognitive capacities than the imitation of *substitute* objects, since pretend acts with appropriate objects are still closely related to the conventional or instrumental function of the involved objects, whereas pretend acts with substitute objects require a decontextualized instead of functional handling. In line with this argumentation, Dohmen (2007) found a significant difference between the performance of a group of 2-year-old children with SLD and a group of age-matched TD children on the imitation of pretend acts with a mix of appropriate and substitute objects. No significant difference was found between a 3-year-old SLD group and an age-matched TD group on the same task, suggesting again that imitation profiles might change according to age. Smith and Bryson (2007) reported no significant difference between the imitation performance of TD and LI groups on a pretend act task with counterfunctional substitute objects. However, in contrast to the two studies revealing significant differences, typical and clinical groups in this study were not matched on chronological age but on language, resulting in a younger TD group (3;4-13;7 years) and an older LI group (6;10-17;8 years).

Overall, a comparison of outcomes is problematical, since studies differ substantially in the way measures were designed and how groups were matched. Tasks presented single pretend acts versus sequences of pretend acts, included appropriate versus substitute objects (or a mix) and sometimes - but not always - accompanied the presentation with verbal and vocal cues (see Table 4). However, despite the multifaceted and inconsistent methodology of different studies, outcomes suggest that children with atypical language development perform more poorly than age-matched TD peers on tasks requiring the imitation of pretend acts with *substitute* objects, i.e. tasks categorised as hybrid measures.

Two studies investigated relations between the ability to imitate pretend acts and language skills in children with atypical language development. On the basis of children's performance on imitation of pretend acts with counterfunctional substitute objects, Smith and Bryson (2007) categorised participants with LI as either *consistent* imitators, i.e. participants who imitated all pretend acts accurately, or *inconsistent* imitators, i.e. participants who used objects in their conventional way instead of imitating the pretended counterfunctional action. They found that the group of consistent imitators had significantly better receptive language skills than the group of inconsistent imitators. Thal and Bates (1988) investigated a group of LT on two tasks measuring imitation of pretend acts on substitute objects (see above and Table 4). One year later they re-assessed language skills of participants who were identified as LT at Time 1, and categorised them as either 'true late talkers' or 'late bloomers' based on their expressive language skills at Time 2. They found that the group of 'true late talkers' in comparison to the 'late bloomers' performed significantly more poorly on the pretend acts measures at Time 1, and thus identified a longitudinal predictive association between the imitation of pretend acts and expressive language skills.

MOTOR SKILLS

Four studies considered children's motor skills and the potential impact that these might have on their nonverbal imitation performance. Results are inconsistent. Vukovic et al. (2010) and Marton (2009) found that groups of children with SLI performed significantly more poorly on different motor tasks than age-matched TD children. Marton (2009) further found gross motor performance to be a concurrent predictor of posture imitation. In contrast, Thal and Bates (1988) reported that all LT performed within the normal range on a fine and gross motor task. Hill (1998) provides a detailed picture and differentiates between children's general motor skills and their actual impact on their imitation performance. She assessed all 19 participants in the SLI group on the Movement ABC (Henderson & Sugden, 1992) and found that 9 children performed within the range of age-matched control participants while 11 children had motor skills outside the normal range (similar to participants with developmental coordination disorder). To evaluate whether the poor gesture imitation performance of the SLI group was solely due to children with poor motor skills, the SLI group was split into SLI pure and SLI clumsy groups. Strikingly, results showed similar performance on imitation of object related gestures and even better performance of the SLI clumsy than the SLI pure group on the imitation of conventional gestures. Consequently, the poor imitation performance of the whole SLI group could not be explained by poor motor skills. Collectively, though, these results highlight the importance of controlling for children's motor abilities in an investigation of nonverbal imitation skills.

EVALUATION

In contrast to the lively interest in nonverbal imitation skills in children with ASD, nonverbal imitation skills in children with atypical language development have rarely been explored. To date, four studies have investigated nonverbal imitation abilities in *school-age* children with language problems (Hill et al., 1998; Marton, 2009; Smith & Bryson, 1998, 2007; Vukovic et al., 2010), and only two studies focussed on nonverbal imitation abilities of *preschool-age* children with language delay (Dohmen, 2007; Thal & Bates, 1988; Thal et al., 1991).

Outcomes of these studies suggest that children with language deficits in comparison to age-matched TD peers have difficulty imitating *intention-sensitive* postures and gestures (Dohmen; Hill et al.; Marton; Vukovic et al.) and pretend acts with *substitute* objects (hybrid measures). However, multifaceted and inconsistent methodology across studies made it difficult to compare outcomes and emphasised the need for precisely designed measures to elicit the imitation of pretend acts, controlling for parameters such as appropriate versus substitute objects as well as single acts versus sequences of acts. Furthermore, outcomes suggested a possible impact of chronological age, language and motor skills on children's nonverbal imitation performance and therefore the possibility that children's nonverbal imitation profiles change with time and maturation. The ability of children with atypical language development to imitate outcome-sensitive instrumental acts has not previously been investigated. Interestingly, the three studies investigating relations between nonverbal imitation (postures and pretend acts) and language revealed significant associations between both skills in children with atypical language development (Smith & Bryson; Thal et al.; Vukovic et al.).

In conclusion, this literature review highlights that children with atypical language development, who were not diagnosed with ASD, appear to perform more poorly than TD peers on nonverbal imitation measures that have been hypothesised to rely on sociocognitive capacities (ISI and hybrid measures). However, the review also emphasizes the need to look in more depth at a range of different nonverbal imitation skills and their specific relations to language to yield a detailed picture of the nature of nonverbal imitation problems and putative *selective* relations to language in children with language deficits. To permit clear conclusions, ISI and OSI tasks as well as receptive and expressive language measures should be presented in one consistent and coherent study design. However, to date no study set out to investigate relations between different measures of ISI and OSI and different language skills in preschool-age children with language problems.

Table 4: Overview of studies investigating nonverbal imitation and language in children with atypical language development

Author & date	Sample: number & age		Language and motor criteria to define groups	Target of imitation task(s)	Outcome & language measures
	Clinical	Control			
Thal & Bates, 1988	**Time 1** LT: n = 9 CA: 18-32 months	TD (LM): n = 9 CA: no information! TD (CA): n = 9 CA: 'close to LT'	LT within lowest 10% range of *expressive* vocabulary skills according to TD peers (measure: Language and Gesture Inventory; Bates et al., 1985) LT &TD (LM) matched on expressive but **not** receptive language; LT had sig. higher receptive language skills than TD (LM) controls TD (CA) group had highest expressive and receptive language skills all participants within normal age range in terms of fine & gross motor skills (measure: Denver Developmental Screening Test; Frankenburg & Dodds, 1969)	Task 1: **single pretend acts with appropriate and neutral substitute objects** Task 2: **sequences of pretend acts with appropriate objects** (presented in forward and reversed order) presentation of pretend acts is accompanied by **verbal cues** (Task 1: supportive, contradictory & neutral comments; Task 2: verbal narrative)	→ **concurrent** • Task 1: LT & TD (LM) groups sig. poorer than TD (CA) group** (no sig. difference between LT & TD [LM]); performance sig. better with real than substitute objects across groups; no effects of language support • Task 2: TD (LM) group sig. poorer than LT & TD (CA) groups*; performance sig. poorer in reversed condition across groups • Expressive language T1 and T2: Mean length of utterance from language sampling
Thal, Tobias & Morrison, 1991	**Time 2: 1 year later** (8 'Time 1 participants' plus 2 newly recruited participants) LT: n=10	TD (LM & CA): n=10			→ **longitudinal** • at T1 group categorized as true LT (T2) sig. poorer than group categorised as LB (T2) on both imitation tasks • language outcome at T2 within LT group: 4 true LT & 6 LB (determined by expressive language)
Smith & Bryson, 1998, 2007	LI: n = 20 CA: 6;10-17;8 years (ASD: n = 20 / CA: 7-18;5 years)	TD (LM): n=20 CA: 3.4-13.7 years	LI & TD group matched on receptive language (measure: Peabody Picture Vocabulary Test-Revised; Dunn & Dunn, 1981)	Task 1: **body postures;** measure: based on deaf alphabet & Test of Imitation of Movements (Berges & Lezine, 1972) Task 2: **object related & communicative gestures** (separate scales) Task 3: **pretend acts on counterfunctional substitute objects**	→ **concurrent** • no sig. difference between LI & TD groups on any imitation task • **pretend acts:** group of children categorised as *consistent imitators* (i.e. correctly imitated all pretend acts) scored sig. higher on receptive language than group of children categorised as *inconsistent imitators* *** (i.e. used some objects in their conventional way)

Table continued overleaf

Author & date	Sample: number & age		Language and motor criteria to define groups	Target of imitation task(s)	Outcome & language measures
	Clinical	Control			
Hill, 1998; Hill, Bishop & Nimmo-Smith, 1998	SLI whole group: n = 19 Mean CA: 9;9 years (SLI whole separated in: SLI-pure: n=8 & SLI-clumsy: n = 11) DCD: n=11 Mean CA: 9;3 years	TD (CA): n=25 Mean CA: 9;8 years TD (YC): n=17 Mean CA: 5;8 years	• SLI group scored < 80 on CELF-R • DCD & TD (CA) groups scored > 80 on CELF-R • TD (YC) scored > 80 on measure 'repeating sentences' of WPPSI • DCD & SLI-clumsy groups performed ≤ 15th percentile on Movement ABC • participants SLI-pure & both TD groups performed > 15th percentile on Movement ABC	Task 1: **object related gestures**; measure: based on Dewey (1993) Task 2: **conventional gestures**; measure: based on Dewey (1993) Task 3: **manual postures & sequences;** measure: based on Kimura & Archibald (1974)	→ **concurrent** • Task 1 & 2: SLI whole group sig. poorer than TD (CA) group on object related*** and conventional** gestures (no sig. difference between SLI whole, DCD & TD (YC)) • Task 1 & 2 (SLI pure vs clumsy):Task 1: similar performance of both SLI subgroups; Task 2: SLI pure group sig. poorer than SLI clumsy group (i.e. imitation deficit found in those with & without recognized **motor difficulties** in SLI group) • same types of error patterns in all groups but with differing frequency (participants with TD and SLI use 'body-part-as-object, make errors in the 'external and internal configuration of objects' and place hands in 'deviant spatial positions'; both groups show no perseverations or substitutions of items) • Task 3: no sig. differences between imitative performance of any group (ceiling effects in all clinical and control groups)
Dohmen, 2007	German-speaking		participants with SLD scored at least ≤ -1.5 SD on 2 or ≤ -2.0 SD on 1 out of 4 subtests of a standardised German language test (SETK-2 or SETK-3) language skills TD children ≥ -1 SD on SETK-2/SETK-3	Task 1: **postures & gestures** Task 2: **sequence of pretend acts with appropriate & substitute objects**; sequence included some verbal and vocal imitative actions	→ **concurrent** • 2yr SLD group sig. poorer than 2yr TD group on both imitation tasks (Task1***; Task 2*) • no sig. differences between 3yr SLD & TD groups on any imitation task • difference on Task 1 primary due to refusal of participants with SLD
	SLD (2yr): n=8 CA: 30-34 months SLD (3yr): n=11 CA: 37-47 months	TD (CA; 2yr): n=10 CA: 30-34 months TD (CA; 3yr): n=15 CA: 37-48 months			

Table continued overleaf

Author & date	Sample: number & age		Language and motor criteria to define groups	Target of imitation task(s)	Outcome & language measures
	Clinical	**Control**			
Marton, 2009	Hungarian-speaking SLI: n = 40 CA: 5;3-6;10 years	TD (CA): n = 40 CA: 5;3 – 6;7 years	SLI group: performed 'approx. 1.5-2.0 years below the age average on different Hungarian language tasks as assessed by SLTs (no standardized language tests published in Hungarian) TD group: 'based on parental reports all children performed at age-appropriate levels in learning and behavior'	Task 1 & Task 2: **body postures** measure: subtasks of Southern California Sensory Integration Test (Ayres, 1980)	→ **concurrent** • SLI group performed sig. lower than TD group on Tasks 1 & 2 (both tasks before*** and after** controlling for nonverbal IQ) • SLI group performed sig. poorer than TD group on motor coordination test***(Koerperkoordinationstest fuer Kinder; Kiphard & Schilling, 1974) • motor performance identified as sig. predictor of imitation of body ** and manual* postures in SLI but not TD group • different error patterns in SLI and TD groups (SLI: primary perseverative errors & complex omissions; TD: primary simple omissions & simple substitutions)
Vukovic, Vukovic & Stojanovik, 2010	Serbian-speaking SLI: N = 30 CA: 4-7 years	TD (CA): n = 30 CA: 4-7 years	SLI group: diagnosed as language impaired by SLTs (no further information about language measures) TD group: no concerns about language or motor development (no further information)	Task 1 & 2: **simple & complex postures** (separate subscales) measure: Test of Imitation of Movements (Berges & Lezine, 1972)	→ **concurrent** • SLI group sig. poorer than TD (CA) group on Task 1** & Task 2** • sig. correlations between scores on imitation of *simple* postures and expressive (r=.37*) & receptive (r=.32*) language and between imitation of *complex* postures & expressive (.37*) language • SLI group sig. worse than TD (CA) group on **motor skills****(subtests of McCarthy's Scales of Children's Abilities; McCarthy, 1972) • Expressive vocabulary: Boston naming test (Kaplan, Goodglass & Weintraub, 1983) • Receptive language: Token test (DeRenzi & Vignolo, 1962) (language tests not standardized on Serbian children)

CA= chronological age; LM= language-matched; SD= standard deviation; * = $p<.05$; ** = $p<.01$; *** = $p\leq.001$

YC= younger control (TD children with lower CA), DCD= developmental coordination disorder, SLD= specific language delay, LI= language impairments, LT= late talkers, true LT= truly language delayed children, LB= late bloomers, SLI= specific language impairment

CELF-R Repeating Sentences= Subtest of Clinical Evaluation of Language Fundamentals - Revised (Semel et al., 1980), Movement ABC= Movement Assessment Battery for Children (Henderson & Sugden, 1992), SETK-2= Sprachentwicklungstest fuer zweijaehrige Kinder (Grimm, 2000), SETK-3=Sprachentwicklungstest fuer drei-bis fuenfjaehrige Kinder (Grimm, 2001), WPPSI= Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1990)

1.4 Rationale for using nonverbal imitation to investigate sociocognitive capacities in children with SLD

Since language acquisition is complex and related to multiple abilities, it is not surprising that children with specific deficits in language do not form a homogeneous group, but have varied profiles (Leonard, 1998). Young children with SLD can present with expressive delay only (Fischel, Whitehurst, Caulfield, & DeBaryshe, 1989), with receptive delay only (Catts, 1993) or with mixed receptive and expressive delay (Paul 1991; Thal et al. 1991, see section 1.5). Furthermore, children's individual language profiles change over time; some children improve or even resolve their deficits but others continue to struggle with language problems that will manifest in heterogeneous profiles of deficits when they get older (Conti-Ramsden & Botting, 1999; Rescorla & Lee, 2000; Snowling, Bishop, & Stothard, 2000).

Researchers have argued that specific deficits in language are the outcome of deficits in multiple underlying skills with different genetic and environmental origins, where the co-occurrence of deficits increases the risk of language deficit (Bishop, 2006; Chiat, 2001). Different profiles of language skills and deficits might be linked to different profiles of underlying skills and deficits. In line with this view, it has been argued that it is important to investigate *different* underlying skills and deficits that might give rise to different profiles of language deficits, and might throw light on the heterogeneous outcomes of early language and communication problems.

The mapping theory (Chiat, 2001), which offers a theoretical account of the developmental trajectory through which language emerges, and particularly the sociocognitive hypothesis which is part of the mapping theory and highlights the contribution of sociocognitive abilities to early language development, provided the starting point for this study of nonverbal imitation in children with SLD.

1.4.1 The mapping theory

At the core of language acquisition is the mapping process, i.e. the discovery of forms, the discovery of meanings, and the acquisition of connections between form and meaning which are specific to a language (Chiat, 2001). The mapping theory argues that language impairments must arise from a breakdown at some point in the mapping process, and focuses on two sets of early processing skills, sociocognitive and phonological, which are hypothesised to be crucial to this process. Both have been associated with concurrent and later language and communication abilities, and it is proposed that either or both may be the root of deficits in language and communication.

The **sociocognitive hypothesis** derived from the theoretical argument that inferring and sharing the speaker's *intended* focus of attention is crucial for discovering the meaning of language. This reasoning is supported by empirical evidence that behaviours such as social referencing (Trevarthen & Aitken, 2001) and joint attention (Baldwin, 1995) are important for early language development in TD children. To share the speaker's intended focus of attention it is not sufficient that children orientate to the same spatial location (e.g. physically see the face of another person or visually detect the object to which a person refers), but that they attune to this person and understand 'that the other participant has a focus of

attention to the same entity as the self' (Tomasello 1995, p. 107). Thus, the sociocognitive hypothesis focuses on children's abilities to interpret a range of pragmatic cues to infer goals and intentions behind actions and utterances within their specific contexts (see section 1.1.4). It has been argued that these behaviours, which rely crucially on sociocognitive capacities, have a 'bootstrapping' role for the acquisition of social communication and language. It is assumed that children use these skills to make sense of events in everyday life (i.e. 'the world') by identifying meaning categories and relations, and to make connections between these extracted meanings and phonological forms, both crucial to the mapping process. Accordingly, it is predicted that constraints on sociocognitive capacities will affect the process of identifying the meaning of words, and hence the discovery and recalling of connections between meanings and forms. Most notable, this will affect the acquisition of language comprehension, but it will also have repercussions for the production of language. Thus, it is expected that children with a primary expressive deficit in syntax and morphology will not display deficits in sociocognitive capacities.

The **phonological hypothesis** derived from the theoretical argument that children require sophisticated skills to break down the stream of speech in order to identify units within this, and to store resulting phonological forms. Empirical evidence that very young TD children are acutely sensitive to phonological features which serve as cues to segment words and identify syntactic relations between words supports this reasoning (Morgan & Demuth, 1996; Weissenborn & Höhle, 2001). Thus, the phonological hypothesis focuses on children's abilities to perceive, recall and produce phonological representations and their 'bootstrapping' role for the acquisition of lexical forms and syntactic structures. It predicts that constraints on phonological processing skills will affect children's progress through the mapping process and therefore affect their lexical and syntactic development. Children with phonological processing deficits are therefore expected to show especially poor morphosyntactic abilities as well as deficits in the acquisition of words and syntax.

Hence, the sociocognitive hypothesis focusses on the bootstrapping role of sociocognitive processing for the interpretation of scenes and repercussions of problems with sociocognitive processing for the identification of meaning categories and relations, whereas the phonological hypothesis focusses on the bootstrapping role of prosodic and phonological processing to extract forms from the stream of speech and repercussions of problems with speech processing for the identification of word forms. Importantly, the mapping theory argues that impacts of sociocognitive and phonological processing difficulties are not limited to the lexical and morphological level. Instead, they extend to the syntactic and morphosyntactic level, since children also use phonological and semantic cues to identify how sentences are structured and to infer their meaning. To be able to abstract and understand syntactic patterns in the input language, i.e. recognise word order and inflection markers and what these tell us about words, children have to be able to identify and hold phonological sequences and to make sense of the situation. As Hirsh-Pasek and Golinkoff (1999, p. 175) phrase it, 'the [...] child can comprehend word order relations only when the prosodic, social, semantic, and syntactic systems act in concert'. Take for example the predicate-argument structure of the verb 'hate' in English. Here, a child has to manage the challenge of abstracting the syntactic pattern 'x hate y'. This is possible by combining information from previously identified phonological sequences (e.g. 'I hate snails', 'she hates Paul' or 'Ben hates Christmas') and meaning

extracted from experiences involving different people who dislike various things, individuals or events and recognising that the experiencer in these situations always precedes the verb. In contrast, the verb 'disgust' requires the child to abstract the same syntactic pattern, 'y disgust x', but recognise that the experiencer follows the verb (e.g. 'snails disgust me', 'onions disgust her' or 'Christmas disgusts her'). Thus, 'mappings between semantic relations and abstract syntactic frames which are the product of earlier established lexical meanings and their combinations become the means of establishing the semantics of verbs and the syntactic frames in which they occur' (Chiat, 2001, p. 123).

It should also be pointed out that linguistic mappings between forms and meanings through which the words and sentence structure of a language are established are assumed to be relatively fragile when children start to acquire language. In the early stages children still rely heavily on redundant language cues to support their immature knowledge (Hirsh-Pasek & Golinkoff, 1999). But once children get a chance to regularly register certain mappings between sounds and meanings in the input of a specific language and thereupon use and practice these in different social contexts, the connections between forms and meanings become more elaborated and resilient.

According to the mapping theory, deficits in different underlying deficits give rise to different language profiles (e.g. deficits in language comprehension versus deficits in expressive syntax and morphology). However, these profiles are not entirely distinct, since different underlying problems can surface in similar characteristics (e.g. deficits in expressive vocabulary); they may also co-occur and result in broader profiles of difficulty (e.g. deficits in comprehension and in production of vocabulary and syntax). Finally, effects of underlying deficits may surface differently at different stages of development.

Chiat and Roy (2008) investigated these hypotheses in a follow-up study of young children referred to clinical services because of concern about language development at the age of 2;6-3;6 years. They predicted that children's performance on early processing skills would be better indicators of specific language outcomes than early language performance itself. They devised the Preschool Repetition Test (PSRep) (Seeff-Gabriel, Chiat, & Roy, 2008), an assessment that requires children to imitate words and nonwords, to measure children's phonological processing skills. Results of the follow-up study revealed that early phonology at 2;6-3;6 years was the strongest predictor of morphosyntax at 4-5 years. These findings are in line with the phonological hypothesis which predicts that children with phonological processing deficits will show especially poor morphosyntactic abilities. In the same study, Chiat and Roy used a set of newly constructed tasks to measure three different behaviours that draw on sociocognitive capacities: response to facial expressions of feelings, engagement in joint attention episodes, and comprehension of different types of symbols. In line with the sociocognitive hypothesis, they found that children's performance on these measures at 2;6-3;6 years was the strongest predictor of social communication at 4-5 years. These results show that performance on *different* measures of processing skills relate to *specific* profiles of language and communication outcomes in 'at risk' children. A key aim of this study was to further investigate the sociocognitive hypothesis using nonverbal imitation as evidence.

1.4.2 Rationale for investigating nonverbal imitation

It section 1.1.4, it was argued that performance on nonverbal imitation tasks, particularly intention-sensitive imitation tasks, is indicative of children's sociocognitive capacities and that children with sociocognitive processing deficits should perform poorly on these tasks. In line with this hypothesis, a review of research provided considerable evidence that children with ASD, who are known to have sociocognitive deficits, performed more poorly than their TD peers on nonverbal imitation measures, especially on those that are hypothesised to draw on sociocognitive capacities (postures, gestures, arbitrary instrumental acts, pretend acts with substitute objects). Furthermore, the review revealed quite consistent relations between those measures that were hypothesised to be indicators of sociocognitive capacities and *receptive language* in children with ASD, whereas the relation between the same measures and *expressive language* was more variable. These findings are in line with the predictions of the sociocognitive hypothesis that children with constraints on sociocognitive capacities will have difficulty identifying the meaning intention behind utterances and mapping and recalling connections between meanings and forms, which will result in difficulties with language, and most notably with receptive language.

Given the hypothesis that some children with specific deficits in language are also expected to have sociocognitive deficits, we would expect some of these children to perform poorly on intention-sensitive nonverbal imitation tasks. However, as discussed in section 1.2.4, only two studies have addressed nonverbal imitation abilities in preschool-age children with early language problems. Both revealed difficulties in toddlers with delayed language development imitating targets that are assumed to rely on sociocognitive capacities, i.e. postures and gestures (Dohmen, 2007), and pretend acts with substitute objects (Dohmen, 2007; Thal & Bates, 1988). However, no study yet has systematically investigated a range of different types of nonverbal imitation and relations to different language skills or language profiles.

As discussed above, Chiat and Roy (2008) considered three different tasks measuring sociocognitive abilities in children at risk of SLD (social responsiveness, joint attention and symbolic comprehension). What might *nonverbal imitation* add as measure of sociocognitive abilities? Different measures of sociocognitive abilities provide information about particular aspects of children's sociocognitive processing. Chiat and Roy's tasks focussed on the perception and comprehension of *input* and required minimal *output* (e.g. pointing). In contrast, imitative responses require production *in addition* to perception and comprehension of input. This additional element, the need to match and reproduce a modelled act, provides a further challenge for children and may offer additional insight into how children process and reproduce different types of input. There is extensive evidence of how children with language deficits reproduce verbal targets, with nonword and sentence repetition seen as key sources of evidence (Conti-Ramsden et al., 2001; Graf Estes et al., 2007), but nonverbal imitation has barely been explored to date. Since nonverbal imitation does not involve forms and structures of language, it provides a window onto sociocognitive abilities without being biased by difficulties with the processing of the structural aspects of language. Thus, it is hypothesised that the active task of nonverbal imitation will throw new

light on facets of children's sociocognitive processing capacities that were not captured by Chiat and Roy's measures.

In conclusion, an investigation of performance on nonverbal imitation, particularly performance on measures of ISI, and how this relates to language might help to clarify *whether and which* profiles of language deficits arise from deficits in sociocognitive abilities in young children with language problems. This would not only add to our understanding of the heterogeneity of early language problems and their outcomes, but would clarify underlying deficits, with implications for intervention.

Based on these arguments, this study set out to investigate nonverbal imitation and relations to language in 2;0-3;5-year-old-children with SLD.

The key aims were:

- to compare the performance of groups of TD children and children with SLD aged 2;0-3;5 years on a range of novel nonverbal imitation tasks in order to determine whether and which nonverbal imitation behaviours significantly differentiate groups
- to investigate relations between performance on ISI measures, as indicators of sociocognitive skills, and measures of receptive and expressive language within the SLD sample.

It was hypothesised that:

- Some children with SLD will have difficulty with nonverbal imitation tasks categorised as intention-sensitive (ISI measures), while nonverbal imitation tasks identified as outcome-sensitive (OSI measures) will be no more challenging for children with SLD than for TD children.
- Children with exclusive *receptive* language delay and *combined receptive and expressive* language delay will show difficulties on ISI measures, whereas children with an exclusive *expressive* language delay will not.

As argued earlier, children's language and imitation profiles are expected to evolve with time and maturation. To investigate whether and how relations between children's nonverbal imitation and language profiles might change over age, this study considered performance across three 6-month age bands within the typical and clinical samples (2;0-2;5, 2;6-2;11 and 3;0-3;5 years).

1.5 Identification of SLD

Since this study is concerned with profiles of children with early language delay, it is important to consider how these children are identified.

1.5.1 Delay versus Impairment

The terms 'language delay' and 'late talker' are commonly associated with young preschool-age children who have been identified with slow language development that is substantially below expectations for the child's age level. Such delayed or late language development cannot be equated with impaired language development. Children with slow language development are considered to be *at risk* of persistent language deficits but not all of these children will necessarily continue to experience language impairments; many outgrow their early language delays and acquire language abilities to within average age level as they get older (Rescorla, Dahlsgaard, & Roberts, 2000; Snowling et al., 2000). Whether a child with language problems will be identified as 'child with language delay' or diagnosed as 'child with language impairment' is conditioned by her or his age. However, there is no consensus in the literature about the exact point in time distinguishing language delay from language impairment. Whereas some authors restrict the 'at risk period' to children up to 3 years (Tager-Flusberg & Cooper, 1999), others extend the period to children up to 4 years (Rescorla & Lee, 2000).

In this thesis, the term 'child with language delay' or more precisely specific language delay (SLD), will be used to refer to clinically referred participants aged 2;0-3;5 years with slow language development substantially below age level.

1.5.2 SLD versus secondary language delay: exclusionary criteria

Children's language problems can be associated with concomitant neurological, sensory or physical developmental disorders or occur for no apparent reason (Bishop, 1997). Strictly speaking, the term language delay does not specify whether children's language problems occur with or without concomitant developmental disorders. Whitehurst and Fischel (1994) therefore differentiate between secondary language delay and SLD. The term 'secondary delay' refers to language problems occurring in the context of other developmental conditions affecting language acquisition, whereas the term 'SLD' refers to language problems with unknown aetiology. Typically, secondary language delay is distinguished from SLD using a set of exclusionary criteria, in which the identification of nonverbal IQ below (for secondary language delay) or within (for SLD) typical limits is presumably the most essential criterion.

This study aims to investigate nonverbal imitation and language skills in children with SLD, in contrast to language deficits associated with other conditions; this determined the definition of recruitment criteria for the clinical groups (see section 2.1.1).

1.5.3 SLD versus late talker: inclusionary criteria

As highlighted earlier in this section, young children with language problems who fulfil exclusionary criteria for SLD do not constitute a homogeneous group but present with varying patterns of strength and weakness. Due to the heterogeneity of language problems across children and the variability of developmental trajectories within children, the identification of children with SLD is by no means a straightforward goal. So far, there is no generally accepted 'gold standard' for a set of defined criteria to identify children with SLD. Selection of criteria is important, since this will influence which children are identified and which types of profiles they will display. SLD is most commonly identified by expressive language delay, determined by low expressive vocabulary or by low expressive vocabulary and limited word combinations (Desmarais, Sylvestre, Meyer, Bairati, & Rouleau, 2008). Expressive language delays have been assessed using different language measures and cut-off criteria (e.g. fewer than 50 words or < 10^{th} percentile) at different points in age (most commonly around 24 months but also earlier, e.g. at 18 months). Toddlers identified with specific *expressive* language delays have frequently been labelled as *late talkers* (Horwitz, Irwin, Briggs-Gowan, Bosson Heenan, Mendoza, & Carter, 2003; Rescorla, 2005), and most researchers define late talkers as toddlers with an expressive language delay and receptive language skills within typical limits (Fischel et al., 1989), with few including toddlers who have combined expressive and receptive delay (Paul, 1991; Thal et al., 1991). Hence, the majority of studies investigating language delay have focussed on children's *expressive* language problems, often excluding or ignoring *receptive* language skills. However, the exclusive focus on expressive delay runs the risk of covering only a certain proportion of children with SLD, although research has shown that receptive language delay is common in children with SLD (Everitt, 2009). Accordingly, Desmarais et al. (2008) have highlighted the need to define language problems observed in children with SLD based on clinical profiles that go beyond the criterion of expressive deficits.

Since the purpose of this study is to add to the understanding of the *heterogeneity* of early language problems and its underlying deficits, this study addresses the whole range of early language profiles. Accordingly, SLD as used in this study includes children with expressive only, mixed receptive and expressive as well as receptive only profiles of language delay. The consideration of *receptive* language is particularly important for this research, since it aimed to investigate relations between *sociocognitive capacities* and language, and - based on the mapping theory - predicted that children with deficits in sociocognitive capacities, as evidenced by nonverbal imitation, will show specific difficulty with language comprehension.

1.6 Selection of nonverbal imitation tasks

To evaluate the predictions specified in section 1.4, a battery of novel nonverbal imitation tasks was constructed. The literature review highlighted the need to present a systematic range of nonverbal imitation tasks to yield a comprehensive insight into the nature of nonverbal imitation skills and deficits. This section will give the rationale for the selection of tasks included in the nonverbal imitation battery.

1.6.1 ISI measures: gestures and postures

To evaluate the hypothesis that some children with SLD will have difficulty with nonverbal imitation tasks categorised as intention-sensitive, and to investigate relations between children's profiles of language and ISI abilities, the nonverbal imitation battery included a range of different measures that required the imitation of body movements. None of these tasks involved objects and none produced an observable functional outcome. All were therefore hypothesised to rely on sociocognitive capacities. Empirical evidence of children with ASD reviewed earlier supported this theoretical rationale. Since the literature review revealed varied results for different types of body movements in selected studies, and to obtain a graduated profile of children's intention-sensitive imitation skills, the assessment battery differentiated between five different types of body movements: facial postures, facial expressions, manual postures, conventional gestures and object related gestures (see Table 5). Targets in the manual posture and gesture tasks differed in that postures did not convey conventional or symbolic meaning, whereas gestures conveyed meaning. This differentiation made it possible to investigate whether children's ability to imitate body movements would be influenced by the factor 'meaning not conveyed' versus 'meaning conveyed'.

1.6.2 OSI measures: common instrumental acts on objects

To investigate the hypothesis that nonverbal imitation tasks categorised as outcome-sensitive would be no more challenging for children with SLD than for TD children, the nonverbal battery included a measure that required the imitation of common instrumental acts on familiar objects. Items in this task involved objects and target acts resulted in observable physical outcomes. They were therefore hypothesised to be relatively independent of sociocognitive capacities. Again, empirical evidence of children with ASD supported this theoretical rationale. Further, the literature review revealed that children with ASD, in comparison to TD peers, had difficulty imitating *arbitrary* instrumental acts on objects, and it was argued that this difficulty was related to the fact that the imitation of arbitrary acts is more reliant on sociocognitive capacities. Since the aim was to assess 'pure' outcome-sensitive behaviour, no arbitrary instrumental acts on objects were included in the assessment battery. Empirical results for children with ASD also raised the question whether the unfamiliarity of objects might influence the ability of children with SLD to imitate instrumental acts on objects. To explore this question, the nonverbal imitation battery included one task requiring imitation of common instrumental acts on *familiar* objects and one on *unfamiliar* objects (see Table 5).

1.6.3 Hybrid measure: Pretend acts

The literature review revealed that children with ASD and those with atypical language had difficulty imitating pretend acts on substitute objects, and that performance on this type of task was related to children's language skills. This is of particular interest since the imitation of pretend acts is on the cusp between serving an instrumental and social function and was therefore categorised as hybrid between ISI and OSI. It was argued that an engagement in pretend acts requires the child to *infer* the intended social benefits of performing such an action, but the involvement of real objects with instrumental functions might at the same time decrease the necessity to focus on the other person and her/his intentions. Thus, it was hypothesised that the imitation of pretend acts draws on children's sociocognitive capacities, but it is unclear whether these are necessary or merely helpful. To investigate whether children with SLD would have difficulty imitating target acts that cannot be clearly categorised as measures of ISI or OSI, the assessment battery included a task with pretend acts on counterfunctional substitute objects.

Table 5 provides an overview of the main tasks making up the nonverbal imitation battery according to their categorisation on the ISI-OSI scale.

Table 5: Main tasks included in the nonverbal imitation battery

ISI measures: Postures & gestures	Hybrid measure: Pretend acts	OSI measures: Instrumental acts
Facial postures Facial expressions Manual postures Object related gestures Conventional gestures	Pretend acts with counterfunctional substitute objects	Common instrumental acts with familiar objects
		Common instrumental acts with unfamiliar objects

SUBTASKS

In addition to the main tasks outlined above, two *subtasks* were incorporated in the nonverbal imitation battery to explore certain aspects of nonverbal imitation in children with SLD that have been previously investigated in children with ASD and TD children. In section 1.1, 'action details', referring to the style or manner in which an action is realised, were considered. Such style or manner details are not necessary to achieve an end-result and therefore do not influence the outcome of an imitative act (e.g. the pushing of a button will evoke an effect regardless of the way in which the button has been pressed). Hobson and Lee (1999) and Hobson and Hobson (2008) compared performance of a group of adolescents with ASD and a group of adolescents with developmental delay (matched on chronological age and verbal mental age) on imitation of outcomes and action details of instrumental acts on objects (e.g. bring a stamp down harshly versus gently on a piece of paper to leave an ink impression). They found that the ASD group performed significantly more poorly in imitating the style in which the instrumental acts were carried out (harshly versus gently), but that groups did not differ in replicating the outcomes of these instrumental acts (leaving an ink impression). To investigate whether children with SLD, like older children with ASD, would have difficulty imitating unnecessary action details, some items in the task 'common instrumental

acts with familiar objects' were further designed to assess imitation of manner or style (e.g. harshly versus gently).

A further subtask incorporated in the task 'common instrumental acts with familiar objects' followed up findings that TD children take a model's reasons for an action into account in interpreting the relevance of an observed behaviour in a specific context (Schwier et al. 2006; see section 2.4.3 for further information and examples).

1.7 Nonverbal imitation errors

Some studies investigating nonverbal imitation in children with ASD and atypical language development have looked in depth at the nature and rate of incorrect attempts to determine whether children's nonverbal imitation errors reflected developmental immaturities or dysfunction. For example, Beadle-Brown (2004) compared incorrect responses produced by TD children at different ages with those produced by school-age children and adults with ASD on a range of different imitation tasks. The study included four participant groups: children with ASD (7;2-15;0 years), adults with ASD (17;5-33;11 years), younger TD children (3;3-3;11 years), and older TD children (5;0-6;2 years). Participants in all groups produced partial errors of the same types across different tasks (e.g. reversals of actions or the use of 'body-parts-as-objects'), but there were differences in the frequency with which these were observed at different ages in that the younger typical *and* ASD groups showed lower scores than the older groups. The authors conclude that the ability to imitate on demand emerges with age and improves in accuracy as individuals get older (in TD children and children with ASD), and they characterise the imitation problems in individuals with ASD as a 'delayed developmentally normal pattern of imitation'. Their results highlight once more that age seems to be an important factor for competence in imitation. Hill et al. (1998) analysed incorrect attempts to imitate gestures in school-age children with SLI in comparison to age-matched TD control groups (see Table 4). Like Beadle-Brown, they found the same types of gesture imitation errors within the SLI and control groups, but differences in frequency. Children in the SLI and control groups used body-parts-as-objects, made errors in the 'external and internal configuration' of objects, and placed their hands in 'deviant spatial positions', but did not show perseverations or substitutions of items. According to the authors, this pattern points toward an immaturity in development rather than a dysfunction of imitation skills in children with SLI. In line with previous results, Marton (2009) found the same types of posture imitation errors in a group of school-age children with SLI and a group of age-matched TD peers (see Table 4). However, while children in the SLI group primary produced perseverative errors and complex omissions, children in the TD group primary produced simple omissions and substitutions. Due to the different *rate* of *certain* types of errors in the SLI and TD group, the author concludes that the imitation performance of children with SLI and TD follow different error patterns, with that observed in children with SLI described as 'complex error pattern', and that observed in TD children as 'simple error pattern'.

Based on these empirical findings and the assumption that children's errors provide a window onto the nature of children's processing (see section 1.1.5), this study aimed to compare nonverbal imitation errors occurring in the typical and clinical samples, to determine whether

- the *types* of errors of children with SLD resemble those of TD children or whether they are qualitatively different; and
- the *rates* of errors of *older* children with SLD resemble those of *younger* TD children.

An error pattern in which the types and rates of errors in an older SLD group resemble those of younger TD children would suggest a delay rather than deviance in nonverbal imitation within the clinical sample.

This study considered two different types of nonverbal imitation errors: incorrect responses (i.e. inaccurate attempts to imitate target acts) and non-compliance (i.e. non-response or refusal to imitate target acts).

Across the literature, there is no general consensus about how to evaluate and interpret non-responses. Indeed, the majority of papers give no information on non-responses or how they were treated. However, findings of studies that have reported children's non-response rates suggest that high(er) rates might be linked to *specific* types of nonverbal imitation measures. For example, Charman et al. (1997, 2003; see Table 1 and Table 2) report similar non-response rates for TD and ASD groups of 20-month-olds on imitation of *instrumental acts on unfamiliar objects*, but dropped a *gesture* imitation task from their study as participants could not be sufficiently engaged in face-to-face imitative interactions. Dohmen (2007; see Table 4) assessed groups of 2-3-year-olds with TD and SLD on a posture and gesture as well as on a pretend acts imitation task. They found that more than one third of the 2-year-old - but not the 3-year-old - children with SLD refused to reproduce any *posture or gesture*, though no child in either group across age ranges refused all items of a *pretend acts task*. Furthermore, numbers of non-responses turned out to relate to the severity of language delay. In line with previous findings, assessing imitation of *instrumental and pretend acts*, (Rogers et al., 2010) found no significant differences among groups of children with ASD and TD aged 2-5 years with respect to numbers of non-responses. Thus, findings suggest higher non-response rates on *posture and gesture* imitation tasks in *preschool-age children* with ASD and SLD in comparison with TD peers, but similar non-response rates in typical and clinical groups on imitation tasks involving real objects (instrumental and pretend acts tasks). However, in contrast to findings in preschool-age children, Hill et al. (1998) reported that *school-age children* with SLI *and* TD produced only very few non-responses on posture and gesture imitation measures. This outcome, together with Dohmen's (2007) results, is a cautious hint that non-response rates might be linked not only to specific nonverbal imitation tasks but also to specific age ranges.

The findings of *specific* refusal to imitate certain target acts do not fit with the assumption that children's non-responses are due to general reticence or uncooperativeness. Rather, they point toward the possibility that non-response is due to a *specific* difficulty with certain target acts. This is supported by wider literature considering whether non-response is due to uncooperativeness or deficit with respect to nonverbal as well as verbal imitation. Rogers et al. (2003) state that 26-41-month-old participants with ASD primarily refused items of an imitation battery with mixed target acts that were most difficult for children in all groups and conclude that non-responses reflect the level of task difficulty rather than poor cooperation. In the same vein, Hoff, Core and Bridges (2008) report that a subsample of 20-24-month-old TD children who refused to imitate words and nonwords had a smaller mean vocabulary score and a lower mean vocabulary percentile compared to the rest of the sample (i.e. children who did not refuse to reproduce words and nonwords). Although this difference was not significant, they interpret non-response as evidence of deficit and not general reticence, at least in most cases. Chiat and Roy (2006) also suggested that children's refusal to imitate words and nonwords reflects inability rather than unwillingness to repeat. They justify their suggestion with the fact that the majority of 2;6-3;6-year-old children who refused to engage in a test of word and nonword repetition also had low language scores on

a parental report of vocabulary. Furthermore, all these non-responders attempted to imitate words and nonwords on the same test when they were followed up at the age of 4-5 years, but their scores were still significantly lower than those of the rest of the sample.

In line with these findings, this study will treat refusal to attempt *specific* target acts, i.e. *selective* non-responding, as evidence of difficulty rather than uncooperativeness with these tasks or items, and as informative about the nature of children's difficulties. The exclusion of specific non-compliance would risk losing important information about children's nonverbal imitation performance. Therefore, children's non-responses were scored as zero and included in the dataset in this study (see section 2.4).

Overall, this study aimed to compare children's patterns of nonverbal imitation errors in the TD and SLD samples, to investigate how incorrect responses and non-responses evolved according to age and tasks between and within groups, with regard to their rate and nature.

1.8 Verbal imitation

While this study clearly focuses on *nonverbal* imitation as a measure of sociocognitive skills, and relations between nonverbal imitation and language in children with SLD, *verbal* imitation was also investigated for two reasons: first, to compare performance on nonverbal versus verbal imitation, and second, to extend assessment tools for German-speaking children. To assess verbal imitation word, nonword and sentence imitation tasks were included (see section 2.4.4).

1.8.1 Response to nonverbal versus verbal imitation

Children with SLD are expected to have difficulty with verbal imitation tasks, since these are assumed to tap structural aspects of language which are a problem for these children. Since nonword and sentence repetition have been proposed as clinical markers for SLI (see section 1.8.2), it is expected that the SLD sample will perform significantly more poorly on all verbal imitation tasks than the TD sample. However, it is possible that children's performance on verbal imitation tasks might in addition be influenced by putative constraints on sociocognitive processing. Since the repetition of verbal items involves no objects, produces no observable physical outcome and requires inferencing of the intended social benefit, it shares characteristic features with *intention-sensitive* nonverbal imitation. Patterns of performance on verbal versus nonverbal imitation may throw more light on this possibility. To date, no study has compared response to nonverbal and verbal imitation skills and explored relations to language.

1.8.2 Verbal imitation tasks as clinical tools for German-speaking children

In contrast to nonverbal imitation, which has received little attention, there has been a lively interest in investigating verbal imitation in children with atypical language development and specifically children with SLI. The main focus of research has been on children's ability to imitate nonwords across a wide age range but there has also been some research on children's imitation of real words. More recently researchers have started to look at children's imitation of sentences. A subsidiary aim of this study was to evaluate the clinical practicability and significance of verbal imitation as assessment tool for young German-speaking children. The three novel German tasks were based on the Early Repetition Battery (ERB) (Seeff-Gabriel et al., 2008).

Word and nonword repetition has been shown to differentiate TD children and children with atypical language development across a wide age range, in English (Casalini et al., 2007; Chiat & Roy, 2007; Gathercole, 2006; Graf Estes et al., 2007; Roy & Chiat, 2004) and in other languages, e.g. Swedish (Sahlén, Reuterskiöld-Wagner, Nettelbladt, & Radeborg, 1999), Italian (Bortolini, Arfé, Caselli, Degasperi, Deevy, & Leonard, 2006) and Spanish (Girbau & Schwartz, 2007), and in children whose language deficits seem to have resolved (Bishop et al., 1996; Conti-Ramsden et al., 2001). The imitation of nonwords has been evaluated as a clinical marker for SLI (Bishop, North, & Donlan, 1996; Conti-Ramsden et al., 2001). The Preschool Repetition Test (PSRep) (Seeff-Gabriel et al., 2008) has been evaluated as an efficient and effective test to detect phonological processing deficits from the age of 24 months which may be predictive of later language impairment (Chiat & Roy, 2007, 2008; Roy & Chiat,

2004), and which provides detailed information about children's abilities to process and store familiar and unfamiliar lexical phonology. To date there is no such word and nonword measure available for 2-year-old German-speaking children with language delay. This study aims to replicate the findings for PSRep using an adapted version of the test with the German-speaking TD and SLD samples participating in the study. It is predicted that children with SLD will have significant difficulties with the word and nonword tests at all age ranges.

Sentence repetition has also been found to differentiate TD children and children with language deficits in English (Conti-Ramsden et al., 2001; Seeff-Gabriel, Chiat, & Dodd, 2010) and in other languages, e.g. Cantonese (Stokes, Wong, Fletcher, & Leonard, 2006) and Italian (Devescovi & Caselli, 2007). It has also been proposed as a clinical marker for SLI, and it appears to achieve the highest levels of sensitivity and specificity (Conti-Ramsden et al., 2001). There is evidence that sentence repetition provides detailed information about morphosyntactic and lexical phonological abilities in TD children (Seeff-Gabriel et al., 2008), clinically referred children (Chiat & Roy, 2008), and children with severe speech difficulties (Seeff-Gabriel et al., 2010). It seems that sentence repetition is an efficient and effective diagnostic tool to identify children who have difficulties with expressive morphosyntax (Chiat & Roy, 2008; Everitt, 2009; Seeff-Gabriel et al., 2010). From a clinical point of view, sentence imitation allows for direct and systematic elicitation of a representative range of morphosyntactic structures using a relatively small, but carefully selected, set of target sentences. It is difficult to elicit a similar representative range of morphosyntactic structures using picture description tasks or spontaneous language samples. To the best of our knowledge, the practicability and informativeness of elicited sentence imitation as a clinical tool has not previously been investigated with 2-year-old children in English or other languages. This study aims to investigate the clinical value of a sentence repetition task for German-speaking children from the age of 24 months. The novel task is an adapted version of the Sentence Imitation Test (SIT) (Seeff-Gabriel et al., 2008) which has been evaluated as a clinical tool to detect morphosyntactic deficits from the age of 30 months; the German adaptation includes shorter, simpler targets appropriate to younger children. It is predicted that children's performance on this sentence imitation task will differentiate groups of TD children and children with SLD.

1.9 Purpose of the current study

Based on the theoretical arguments and empirical findings reported in this chapter, the current study set out to investigate nonverbal imitation and relations to language in 2;0-3;5-year-old-children with SLD. Since children's language and imitation profiles are expected to evolve with time and maturation, this study considered performance across three 6-month age bands within the TD and SLD samples (2;0-2;5, 2;6-2;11 and 3;0-3;5 years).

1. The first key aim was to compare the performance of groups of TD children and children with SLD on a range of novel nonverbal imitation tasks in order to determine whether and which nonverbal imitation behaviours significantly differentiate groups.

   It was hypothesised that some children with SLD will have difficulty with nonverbal imitation tasks categorised as intention-sensitive (ISI measures), while nonverbal imitation tasks identified as outcome-sensitive (OSI measures) will be no more challenging for children with SLD than for TD children.

2. The second key aim was to investigate relations between performance on ISI measures, as indicators of sociocognitive skills, and measures of receptive and expressive language within the SLD sample.

   It was hypothesised that children with exclusive receptive language delay and combined receptive and expressive language delay will show difficulties on ISI measures, whereas children with an exclusive expressive language delay will not.

To evaluate the hypotheses, a battery of novel nonverbal imitation tasks was constructed. It included a range of measures that required the imitation of ISI and OSI measures:

- *ISI measures.* The battery differentiated between five different types of body movements. None of these tasks involved objects and none produced an observable functional outcome. All were therefore assumed to rely on sociocognitive capacities.
- *OSI measures.* The battery differentiated common actions on familiar and unfamiliar objects. Both tasks involved real objects and target acts resulted in observable unambiguous outcomes. They were therefore assumed to be relatively independent of sociocognitive capacities.
- *Hybrid acts.* Another type of task, the imitation of pretend acts on substitute objects, was included in the battery to explore whether children would have difficulty imitating target acts that are on the cusp between serving an instrumental and social function. It was argued that an engagement in pretend acts draws on children's sociocognitive capacities, but it is unclear whether these are crucial or merely helpful.

3. Further, this study aimed to compare nonverbal imitation errors occurring in the TD and SLD samples, to determine whether

   - the types of errors of children with SLD resemble those of TD children or whether they are qualitatively different; and
   - the rates of errors of older children with SLD resemble those of younger TD children.

An error pattern in which the types and rates of errors in an older SLD group resemble those of younger TD children would suggest a delay rather than deviance in nonverbal imitation within the clinical sample.

4. A subsidiary aim of this study was to compare the performance of TD and SLD groups on a range of verbal imitation tasks (word, nonword and sentence tests).

   It was hypothesised that children's performance on all verbal tests will differentiate groups of TD children and children with SLD, since groups were defined by typical versus delayed language development.

2 Methodology

This study included two samples of 2;0-3;5-year-old German-speaking participants: a sample of typically developing children (TD) and a sample of children with specific language delay (SLD). Children within both samples were divided into three age groups: range A (2;0-2;5 years), range B (2;6-2;11 years) and range C (3;0-3;5 years). All participants were systematically assessed on a battery of novel tasks to elicit immediate nonverbal and verbal imitation, and furthermore on a range of measures to detect language, to ensure the fulfilment of selection criteria, and to record potentially influential characteristics of participants.

The first key aim of this study was to compare the performance of the TD and SLD samples on a range of nonverbal imitation tasks categorised as intention-sensitive, outcome-sensitive and hybrid measures at each age range. The second key aim was to investigate relations between performance on ISI measures, as an indicator of sociocognitive abilities, and performance on receptive and expressive language measures within the SLD sample at each age range. A subsidiary aim was to compare the performance of the TD and SLD samples on a word, nonword and sentence imitation tasks at each age range.

2.1 Recruitment of participants

2.1.1 Recruitment criteria

Children were eligible to participate if they satisfied the following criteria:

- age between 2;0-3;5 years
- German is main language
- no significant history (past or current) of general developmental delay or disorder (congenital or acquired), including:
  - physical and neurological development
  - perceptual/sensory development (especially hearing)
  - nonverbal cognitive development (nonverbal IQ score of 85 or above).

In terms of the allocation to groups, children in the clinical group additionally had to meet the criteria of specifically delayed language development. Participants were defined as having SLD when they performed at least 1.5 standard deviations (SD) below average on one subtest and 1.25 SD below average on another subtest out of four (2-year-old-children) and five (3-year-old-children) subtests of standardised language assessments.

Any violation of the above criteria resulted in exclusion of a potential participant to minimise:

- developmental problems which could be sources of delayed language development, i.e. to include children with SLD and to exclude children with secondary language delay
- inequalities between the typical and clinical groups which might have an impact on the comparison of children's imitation skills and the interpretation of results.

In addition to these exclusion criteria, the following four characteristics of participants were recorded during the recruitment process but did *not* lead to exclusion of potential participants:

- children's gross and fine motor skills
- children's risk for ASD
- children's socio-economic background
- the duration of any language therapy administered to children in the clinical sample.

The purpose of recording these was to permit them to be investigated as potential co-variants and considered in the interpretation of results.

2.1.2 Recruitment procedure

Ethical approval for the study was given by the City University School of Community and Health Sciences Research Ethics Committee (Appendix A.1). Participants with SLD and TD participants were recruited in the areas of Bonn and Magdeburg/Helmstedt in Germany. Bonn is a city with 317,595 inhabitants in the federal state North Rhine-Westphalia in West Germany (Stadt Bonn, 2010). The average annual net income in Bonn is about 19,290 Euro (Stadt Bonn, 2010); the unemployment rate is about 6.2% (Bundesagentur für Arbeit, 2010). Magdeburg is a city with 231,171 inhabitants (Land Sachsen-Anhalt, 2010) in the federal state of Saxony-Anhalt in East Germany. Magdeburg has a lower socio-economic status than Bonn, with an average annual net income of 14,634 Euro (Land Sachsen-Anhalt, 2010) and an unemployment rate of about 11.1% (Bundesagentur für Arbeit, 2010).

Participants with SLD were recruited by paediatricians, speech and language therapists (SLT), phoniatricians and nursery teachers through clinical paediatric practices, clinical practices for speech and language therapy, phoniatric clinics, a paediatric specialist centre and nurseries in Bonn and Magdeburg. Participants with TD were solely recruited by nursery teachers (see Appendix A.2 & A.3 for detailed information about the recruitment procedure and participating institutions).

Nurseries and clinical institutions were contacted by a letter inviting them to participate, followed up by a phone call (see Appendix A.4 & A.5). On agreement to be involved in the research, nursery staff and clinicians were sent written information about the general recruitment criteria and identified children who satisfied these selection criteria. Recruitment criteria were also discussed individually on the phone or at team meetings.

Parents of potential participants were approached in person by nursery staff and clinicians. Because children included in this study were too young to give consent, informed consent was understood to be informed parental permission and assent of the child. Parents who had expressed an interest in participating in the study were given an information sheet and consent form to be completed and returned prior to the assessment (see Appendix A.6).

2.2 Background assessments

This section describes and gives the rationale for the selection of all assessments that were used

- to ensure the fulfilment of the selection criteria
- to record potentially influential characteristics of participants.

Table 6 gives an overview of all measures.

Table 6: Overview of background assessments

<table>
<tr><td rowspan="2">Recruitment criteria and information</td><td colspan="3">Age</td></tr>
<tr><td>A (2;0-2;5 years)</td><td>B (2;6-2;11 years)</td><td>C (3;0-3;5 years)</td></tr>
<tr><td>Background information</td><td colspan="3">Parental questionnaire: information on children's general development, language development and socio-economic background</td></tr>
<tr><td>Nonverbal IQ</td><td colspan="3">Standardised IQ test: special Nonverbal Composite Battery of the British Ability Scales Second Edition (BAS II)</td></tr>
<tr><td>Gross and fine motor skills</td><td colspan="3">Standardised developmental test: subtests gross and fine motor skills of the Entwicklungstest 6-6 (ET 6-6)</td></tr>
<tr><td>Risk for ASD</td><td colspan="3">Parental questionnaire: german version of the Modified Checklist for Autism in Toddlers (M-CHAT)</td></tr>
<tr><td rowspan="2">Language status</td><td rowspan="2">Standardised general language developmental test: Sprachentwicklungstest für zweijährige Kinder (SETK-2: all four subtests)</td><td>Standardised general language developmental test: Sprachentwicklungstest für drei-bis fünfjährige Kinder (SETK-3: two subtests)</td><td></td></tr>
<tr><td>Standardised general language developmental test: Patholinguistische Diagnostik bei Sprachentwicklungsstörungen (PDSS: three subtests)</td><td></td></tr>
</table>

2.2.1 Background information: parental questionnaire

The content of the parental questionnaire was designed to ensure the fulfilment of recruitment criteria and to record potential co-variants of group status. It was informed by previous studies conducted within the City research team (Chiat & Roy, 2008; Dohmen, 2007).

The first part of the questionnaire contained questions relating to the child's general developmental history, including preterm birth, major health or medical problems as well as glue ear. One question specifically asked about potential concerns regarding the child's development or health expressed by a paediatrician in any preventive screening. In Germany, 11 preventive screenings, called 'Kindervorsorgeuntersuchungen' or colloquially 'U-Untersuchungen', are routinely carried out by paediatricians at specified ages during childhood, each focussing on different diagnostic targets related to children's developmental stages (see Appendix B.1). They are voluntary but highly recommended and costs must be covered by all public as well as private health insurers. Between the 21st and the 24th month, the screening *U7* is carried out, which focuses on children's body functions, cognitive development, fine and gross motor skills, social behaviour, language, hearing and vision (Bundesausschuss der Ärzte und Krankenkassen, 2009).

The second part of the questionnaire asked about the child's language development, including questions related to the child's main and potential second/third language as well as any speech or language therapy the child had received, both of which might have had an influence on children's imitative skills. The third part contained questions about the child's attendance at a nursery or childminder. The last part collected information about the education of parent(s), since socio-economic status is well known to affect child development (Hoff, 2003; Hoff & Tian, 2005). Parents/carers living in the household of a participant were asked separately about their educational achievements in terms of schooling (secondary general, intermediate secondary, or grammar) and professional education (vocational training, university degree or no professional training). The full questionnaire is provided in Appendix B.2.

2.2.2 Nonverbal IQ

Three German assessments were considered for assessment of children's cognitive skills: the Snijders-Oomen Non-verbaler Intelligenztest (SON-R 2 ½) (Tellegen, Winkel, Wijnberg-Williams, & Laros, 2005), a nonverbal intelligence test that measures children's cognitive skills regardless of language ability within the age range of 2;6-7;0 years; the subtest 'dimension cognitive development' of the Entwicklungstest 6-6 (ET 6-6) (Petermann, Stein, & Macha, 2005), a general developmental test standardised for the age range 6 months to 6 years; and the German version of the Bayley Scales of Infant Development II (Bayley II) (Bayley, 1993; Reuner, Rosenkranz, Pietz, & Horn, 2007). These assessments were not chosen for this study for the following reasons:

- no German norms available (Bayley II) or norms estimated using regression modelling (SON-R 2 ½);
- use not recommended for administration with children younger than 37 months due to the risk of floor effects and uncooperativeness (SON-R 2 ½);
- administration of the subtest 'dimension cognitive development' (ET 6-6) not recommended for children with LI (Macha, Daseking, Vogel, & Petermann, 2008);
- requirement of extensive resources, administration time and material (SON-R 2 ½, Bayley II).

A translation of the assessment The British Ability Scales Second Edition (BAS II) (Elliott, Smith, & McCulloch, 1996) was favoured and selected for this study on the grounds that this nonverbal assessment was used effectively and discriminatingly with German-speaking children in a previous study (Dohmen, 2007). Participants' performance in this study was as expected, i.e. in line with English norms, and confirmed the assumption that standard scores were also valid for the population of German-speaking children. In addition, the application of the BAS II permits comparability with studies on English-speaking children.

The BAS II is a standardised battery of subtests that measures children's cognitive skills and educational achievements over the age range 2;6-17;11 years. The Special-Nonverbal Composite (early years lower level) of the BAS II is a validated scale of intelligence regardless of language ability that has been standardised on English-speaking children for the age range 2;6-3;5 years. This was used to measure children's general nonverbal abilities in the two older age groups to ensure that participants did not have general cognitive delay or disorder. The composite consists of two subtests, block building and picture

similarities. For each subtest, all of the correct responses were added to calculate the subtest raw score. Following the scoring procedure, each subtest raw score was first converted to an ability score and secondly converted to a T-score. Finally the sum of T-scores was translated into a Special Nonverbal Composite standard score (mean of 100, SD of 15) using age-specific conversion tables in the administration and scoring manual. Both subtests are administered with a minimum of verbal instructions and within approximately 15-20 minutes.

Since there is no suitable standardised measure for children under 2;6 years, children's cognitive development within the youngest age group was checked through parental questionnaires and questioning of health professionals and nursery teachers who had referred participants.

2.2.3 Gross and fine motor skills

The nonverbal tasks of the imitation battery involve the production of postures and gestures as well as the handling of objects and therefore require basic motor and praxis skills. Insufficient motor skills might therefore influence children's imitation performance. Studies have found co-morbidity between motor deficits and SLI (Hill, 2001). Consequently, the impact of participants' motor skills has to be considered in comparing imitative performance of TD children and children with SLD.

Children's motor skills at all age ranges were assessed with the two subtests 'dimension gross motor' skills and 'dimension fine motor skills' of the ET 6-6, a general developmental test standardised on German-speaking children for the age range 6 months to 6 years, comprising seven different subscales or developmental dimensions that assess a wide range of developmental skills. The dimension gross motor skills measures children's body control and locomotion, focussing on children's ability to differentiate and integrate elements of body control by accomplishing everyday actions and play skills like climbing stairs, jumping, balancing or using a tricycle. The dimension fine motor skills tests children's skills in manipulating and using objects including targeted grasping and releasing of objects of different sizes and the handling of pens and scissors. Following the test protocol, each age group was assessed on a specific selection of items. Two-thirds of the items are directly administered by the investigator while playing with the child. Information about the remaining third of the items is obtained through a parental questionnaire. The direct administration of both subtests takes approximately 10 minutes (Macha & Petermann, 2008). For each subtest, all of the correct responses obtained from direct testing and the parental questionnaire are summed to calculate the subtest raw score. The raw score is converted to a 'dimension-specific test value', based on gender and age-specific standardisation data. The dimension-specific test values can be transformed to percentile scores using conversion tables in the manual.

2.2.4 Risk for ASD

Although children who had been diagnosed with ASD prior to or during the assessment period were excluded from the study, children meeting recruitment criteria might nevertheless be at risk of ASD. It is well established that children with ASD have deficits in imitation and it has been debated whether these imitative deficits are specific to ASD (Williams et al., 2004). Risk for ASD should therefore be considered regarding the possible impact on children's imitation skills and the interpretation of results. With regard to children's age, special needs and the core aims of this study, it was not appropriate to administer an extensive autism diagnostic instrument such as the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999). Instead, two validated screening measures designed to measure symptoms associated with ASD that can be completed by a parent/carer without supervision and within a limited amount of time were considered for this study: the German translation of the Modified Checklist for Autism in Toddlers (M-CHAT) (Robins, Fein, Barton, & Green, 2001) and the German version of the Social Communication Questionnaire (SCQ) (Bölte & Poustka, 2006; Rutter, Bailey, Lord, & Berument, 2003). The M-CHAT is composed of 23 closed questions that require a yes/no response and is validated for screening toddlers between 16-30 months (see Appendix B.3). Yes/no answers are converted to pass/fail responses, with a maximum possible score of 23. A child fails the checklist when either two or more of six defined critical items are failed or when any three items are failed. A shortcoming of the M-CHAT is its high false positive rate indicating its over-sensitivity, reflected in a positive predictive value of only .36 (Kleinman et al., 2008). The SCQ consists of 40 closed questions that require a yes/no response and is validated for screening children of any chronological age above 4;0 years. Consequently, both screenings have limitations regarding the age of participants included in this study, though the M-CHAT is at least validated for the youngest age group and has been administered to older children in previous studies (Eaves, Wingert, & Ho, 2006). Therefore the M-CHAT was selected in this study. Based on the report of Eaves et al. (2006), a child failed the checklist when any three items were failed and not when two or more critical items were failed. Due to the limitations of the M-CHAT regarding its specificity and the defined age-range, it was decided to record, describe and consider children's risk for ASD but not to exclude any child due to a positive score.

2.2.5 Language status and language performance

Children's language abilities at different age ranges were assessed using a combination of subtasks from three standardised general language tests (see Table 6). All three tests are validated, reliable measures of language ability in young children and are widely used in clinical practice.

TWO YEAR OLD CHILDREN

Children in the two younger groups were assessed with the Sprachentwicklungstest für zweijährige Kinder (SETK-2) (Grimm, Aktas, & Frevert, 2000). The SETK-2 is a standardised test that was constructed to measure children's general stage of language development between 24-35 months and involves the use of picture stimuli and objects. It is the only published general language test for this age group in Germany and comprises four subtests to assess receptive and expressive language competencies

at word and sentence level. Table 7 provides an overview and brief description of language subtests of the SETK-2.

Table 7: Overview and description of subtests of the SETK-2

Name of subtest	Number of items	Requirement for child	Language competence tested
Word comprehension	9	Select one picture out of a range of four	Comprehension of concrete and frequent nouns
Sentence comprehension	8		Comprehension of simple sentences
Word production	30	Name real and pictured objects	Production of concrete and frequent nouns of increasing complexity
Sentence production	16	Describe pictured events	Production of phrases and sentences

For each subtest, all of the correct responses are summed to calculate the subtest raw score. The raw score is converted to a standard T-score using an age-specific conversion table in the manual (mean of 50, SD of 10). Each subtest is scored separately and it is not possible to combine results of subtests to give a standardised total language score. The administration of all subtests takes a maximum of 25 minutes.

THREE YEAR OLD CHILDREN

Two subtests of the Sprachentwicklungstest für dreijährige Kinder (SETK-3) (Grimm & Akta, 2001) and three subtests of the Patholinguistische Diagnostik bei Sprachentwicklungsstörungen (PDSS) (Kauschke & Siegmüller, 2009) were chosen to test children's language abilities in the oldest group. These were selected since they assess a range of receptive and expressive language competencies in semantics, syntax and morphology and are informative about children's language profiles at word and sentence level. However, no measure of children's sentence production was administered. Available measures at this age either involved the imitation of sentences or required a qualitative analysis of elicited sentences. The imitation of sentences is part of the imitation battery and therefore not suitable. The elicitation of a representative range of sentence structures can be problematic, especially when assessing very young children. In addition, the analysis of elicited sentences is disproportionately time-consuming.

Table 8 provides an overview and brief description of language subtests of the SETK-3 and the PDSS. The scoring procedure for all five standardised subtests is identical to that described above for the SETK-2 and the administration of all subtests takes approximately 45 minutes.

Table 8: Overview and description of subtests of the SETK-3 and PDSS

Name of subtest	Number of items	Requirement for child	Language competence tested
Noun comprehension (PDSS)	20	Select one picture out of a range of three	Comprehension of concrete nouns of increasing complexity
Verb comprehension (PDSS)	20		Comprehension of verbs of increasing complexity
Sentence comprehension (SETK-3)	15	Act out events using real objects	Comprehension of sentences of increasing complexity
Noun production (PDSS)	20	Name pictured objects	Production of concrete nouns of increasing complexity
Plural marker (SETK-3)	10	Complete sentence of instructor (Children are shown pictures of a single object and a set of the same objects. Instruction: "Here is one book and there are many ...?")	Produce the morphological plural marker of nouns

LANGUAGE PERFORMANCE

The above language measures were selected for two purposes: to allocate children to groups, and to identify language performance as a basis for exploring relations between performance on ISI and language within the clinical sample (see section 3.6 and 3.7). As can be seen in Table 9, all the SETK subtests were used for both purposes. However, the PDSS subtests noun and verb comprehension were used only with the two older age groups and for different purposes. They were used for both classification *and* profiling in the *oldest age group*, since the subtest of the SETK-3 (see Table 8) alone was not sufficient for classification of children at this age. These PDSS subtests were therefore given to both typical and clinical groups. In contrast, the SETK-2 subtests (see Table 7) were sufficient for classification of children under 3 years, but the PDSS subtests (see Table 8) were administered to the middle age group (2;6-2;11 years) to provide a more differentiated analysis of children's word comprehension. They were not administered to the youngest age group due to the more limited attention capacity of children at this age, and the need to minimise assessment time and demands.

Table 9 gives an overview of all language subtests used for classification and profiling in the typical and clinical samples according to age.

Table 9: Overview of language subtests used for classification and profiling in the typical and clinical samples

Language competencies	Receptive skills			Expressive skills		
	Nouns	Verbs	Sentences	Nouns	Sentences	Plural marker
A (2;0-2;5)	SETK-2	---	SETK-2	SETK-2	SETK-2	---
B (2;6-2;11)	SETK-2 / **Additional subtest clinical group:** PDSS	**Additional subtest clinical group:** PDSS	SETK-2	SETK-2	SETK-2	---
C (3;0-3;5)	PDSS	PDSS	SETK-3	PDSS	---	SETK-3

2.3 Participants

2.3.1 Number, age, gender and language background

Altogether 60 TD children and 45 children with SLD participated in the study. Approximately half of the TD children and children with SLD were recruited in Bonn and Magdeburg, respectively (TD children: 31 Bonn and 29 Magdeburg; children with SLD: 22 Bonn and 23 Magdeburg; see Appendix A.2). Sixteen of the 121 children referred to the study by nursery teachers and health professionals were excluded from the study for a variety of reasons (see section 2.3.9).

The typical and clinical samples each ranged in age from 2;0-3;5 years with a mean age of 32.5 months (SD 5.15) in the typical sample and 31.6 months (SD 5.61) in the clinical sample. The typical sample comprised 27 girls and 33 boys, the clinical sample comprised 16 girls and 29 boys. The typical and clinical samples were subdivided into three 6-months age ranges. Table 10 presents number of participants according to sample (typical and clinical), age range and gender. A Mann-Whitney-U test or when possible an independent t-test was conducted between the age medians/means of the typical and clinical groups and revealed no significant differences between the groups as a whole ($z = -.89$, ns), and for each age range (group A: $t(37) = 1.16$, ns; group B: $z = -1.03$, ns; group C: $z = -.18$, ns). The clinical sample included more boys than girls, reflecting the well-established ratio of boys to girls typically observed in children with specific deficits in language.

Table 10: Number, age and gender distribution of participants in the TD and SLD samples

Typical sample								
Age range	**A (2;0-2;5)**		**B (2;6-2;11)**		**C (3;0-3;5)**		**Total**	
n participants	20		20		20		60	
Mean age *	**26.6**		**32.5**		**38.3**		**32.5**	
SD	1.63		1.88		2.00		5.15	
Median age*	27.00		33.00		38.00		33.00	
range min / max*	24	29	30	35	36	41	24	41
n female / male	10	10	9	11	8	12	27	33
Clinical sample								
Age range	**A (2;0-2;5)**		**B (2;6-2;11)**		**C (3;0-3;5)**		**Total**	
n participants	19		11		15		45	
Mean age *	**26.1**		**31.8**		**38.4**		**31.6**	
SD	1.24		1.40		2.03		5.61	
Median age*	26.00		32.00		38.00		31.00	
range min / max*	24	29	30	34	36	41	24	41
n female / male	6	13	4	7	6	9	16	29

* in months

German was the main language of all children included in the study, though German was not every child's only language. In the typical sample 5 children (8.3%) had English, French (3x) or Turkish as a second language and in the clinical sample 4 children (8.8%) had Dutch, English, Russian or Turkish as a second language.

2.3.2 General development

Altogether 54 (90%) of the 60 questionnaires handed out to parents of TD participants and 44 (97.7%) of the 45 questionnaires handed out to parents of participants with SLD were returned to the investigator. According to parental report no child who was included in the study had a significant past or current history of general developmental delay or disorder. No concerns about major developmental, health or medical problems were expressed by paediatricians at any preventive screening. Parental reports were confirmed by the referring health professional or nursery teacher. No child had a history of specific early childhood intervention but 4 TD children (6.6%) and 6 children with SLD (13.3%) had received physiotherapy and 2 children with SLD (4.4%) had received occupational therapy at an earlier age. One child with SLD was prematurely born at 36 weeks gestation and one TD pair of twins was included in the study.

Fourty-three children (40.95%) had a history of ear infections and/or glue ear. Fifteen TD children (25.0%) and 14 children with SLD (31.1%) had approximately one to two infections to date and 8 TD children (13.3%) and 6 children with SLD (13.3%) had approximately three to five ear infections to date. No child in the typical or clinical group had more than three to five episodes of otitis media during her/his life. According to parental report no child included in the study had acute otitis media or glue ear shortly prior to or during the assessment period. In addition, there were no concerns about any child's hearing according to the latest audiometric check.

2.3.3 Language

Children in each group met language criteria for allocation to that group. Since performance on the language tests also served to identify language performance relevant to analyses, description of language performance is presented in the results chapter (see section 3.6.2).

2.3.4 Nonverbal IQ

AGE 2;0-2;5 YEARS

Nineteen of 20 parental questionnaires of TD participants (95%) and all 19 parental questionnaires of participants with SLD in the youngest group were returned to the investigator. None of the parental questionnaires showed reported any concern regarding a child's cognitive development. In addition, according to parents, no concerns regarding a child's cognitive development were expressed by paediatricians in the preventive screening U7 conducted between the 21st and 24th month. Further, no child in the youngest group received early childhood intervention which might have been an indicator of general cognitive delay or disorder. In the TD group each parental judgement was confirmed by the judgement of a nursery teacher. In the SLD group each parental judgement was confirmed either by the referring health professional (paediatrician, phoniatrician or SLT: 14 children) or the nursery teacher (5 children).

Table 11: Nonverbal IQ of participants in the TD and SLD groups B (2;6-2;11 years) and C (3;0-3;5 years)

Group	n	SD	Nonverbal IQ*		Range	
			Mean	Median	Min	Max
typical B	20	7.58	103.25	101.50	95	127
clinical B	11	4.51	97.82	99.00	89	102
typical C	20	8.40	107.55	105.50	97	129
clinical C	15	4.78	97.20	96.00	90	106

*standard score (mean=100 and SD=15)

AGE 2;6-3;5 YEARS

All children in the two older TD and SLD groups attained standard scores on the BAS II between 89 and 129 (see Table 11). Thus, all children fulfilled the selection criterion of nonverbal IQ within 1 SD of the mean (≥85). A Mann-Whitney-U test compared the nonverbal IQ medians of the typical and clinical groups B and revealed no statistically significant difference ($z = -1.95$, ns). In contrast, the typical group C performed significantly better on the BAS II than the clinical group C ($t(33)$, $p<.001$). Since all children scored within norms, all children in the clinical groups qualified as having SLD, and a deficit in nonverbal IQ could be ruled out in interpretation of performance on nonverbal imitation tasks. However, for the interpretation of results it should be kept in mind that there was a significant difference on nonverbal IQ between the oldest typical and clinical groups.

2.3.5 Gross and fine motor skills

As can be seen in Table 12, all TD children and children with SLD whose questionnaires were returned to the investigator, allowing full scores to be calculated (see section 2.2), attained scores above the 10th percentile on the *gross and fine motor development* subtests of the ET 6-6. Comparison of the typical and clinical groups' performance using Mann-Whitney-U tests revealed no significant difference on any of the subtests in any age range (gross motor development: A ($z = -1.73$, ns); B ($z = -.30$, ns); C ($z = -1.09$, ns); / fine motor development: A ($z = -.88$, ns), B ($z = -.244$, ns); C ($z = -1.88$, ns)). Thus, any differences observed in nonverbal imitation tasks conducted for this study cannot be attributed to children's motor abilities.

Table 12: Gross and fine motor skills of participants in the TD and SLD samples according to age and group (A=2;0-2;5 years; B=2;6-2;11 years, C=3;0-3;5 years)

Gross motor skills												
	Typical sample						Clinical sample					
Age range	A		B		C		A		B		C	
n included	19		17		18		19		10		15	
n missing	1		3		2		0		1		0	
Mean score*	7.36		6.46		6.20		6.63		6.66		5.71	
SD	1.16		1.58		1.11		1.30		1.38		1.25	
Median score*	8.0		6.66		6.24		6.0		6.66		5.83	
Range min/ max*	5	9	4.44	8.88	4.16	7.5	4	9	4.44	8.88	4.16	7.5
Fine motor skills												
	Typical sample						Clinical sample					
Age range	A		B		C		A		B		C	
Mean score*	7.50		6.85		8.33		6.97		6.99		7.10	
SD	1.86		1.43		2.06		1.78		1.05		1.72	
Median score*	7.50		6.66		10.00		7.50		6.66		6.66	
Range Min/ max*	5	10	3.33	10	3.33	10	5	10	6.66	10	3.33	10

* score = dimension-specific test value (norms specified for dimension, gender and age)

2.3.6 Risk for ASD

The M-CHAT was handed out to parents/carers of participants in both groups, and 90 of 105 (93.3%) were returned to the investigator. The following numbers of participants failed the checklist:

- group A: 4 TD children and 3 children with SLD
- group B: 1 TD child and 1 child with SLD
- group C: 1 TD child and 0 children with SLD.

All children with SLD who failed the checklist had been referred by paediatricians and no concerns about a risk of ASD had been expressed. With regard to the TD children, the investigator did not observe any symptoms associated with ASD, either online during the sessions or while scoring the video-recorded assessments. Importantly, children who failed the checklist were almost equally distributed across the typical and clinical groups. As pointed out above, the M-CHAT has been found to be over-sensitive and outcomes in both groups are in line with this finding.

2.3.7 Socio-economic background

TD participants and participants with SLD were drawn from a range of different socio-economic backgrounds in different areas of Germany (see section 2.1.2) and groups were matched on these variables. Table 13 shows a breakdown of mothers and fathers, respectively, of TD children and children with SLD in each age group according to school type and professional qualification. The category 'no information' includes parents/carers who did not hand back the questionnaire to the investigator and parents/carers who refused to give information about their education.

Table 13: Percentage of mothers/fathers of TD children and children with SLD in each age range according to school type and professional qualification (A=2;0-2;5 years; B=2;6-2;11 years; C=3;0-3;5 years)

Schooling									
		Secondary general school		Intermediate secondary school		Grammar school		No information	
		TD	SLD	TD	SLD	TD	SLD	TD	SLD
A	Mothers	5	15.8	30	26.3	55	57.9	10	0
	Fathers	10	15.8	25	21.1	55	57.9	10	5.3
B	Mothers	0	9.1	30	27.3	55	54.4	15	9.1
	Fathers	5	9.1	30	27.3	45	54.4	20	9.1
C	Mothers	0	26	5	40	85	26.7	10	6.7
	Fathers	0	46.7	10	6.7	80	40	10	6.7
Professional training									
		Vocational training		University degree		No professional training		No information	
		TD	SLD	TD	SLD	TD	SLD	TD	SLD
A	Mothers	30	26.3	35	52.6	5	10.5	30	10.5
	Fathers	35	31.6	40	47.4	0	0	25	21.1
B	Mothers	20	18.2	50	54.5	5	0	25	27.3
	Fathers	35	18.2	30	54.5	0	0	35	27.3
C	Mothers	15	33.3	75	20	0	0	10	46.7
	Fathers	15	26	70	13.3	5	0	10	60

In group A (2;0-2;5 years), parental educational achievements are roughly equally distributed in the TD and SLD groups, except that a higher percentage of mothers of children with SLD (52.6%) in comparison to mothers of TD children (35%) achieved a university degree.

In group B (2;6-2;11 years), there were no group differences in schooling of mothers and fathers. Professional training is equally distributed for mothers of TD children and children with SLD but a higher percentage of fathers of children with SLD (54.5%) achieved a university degree in comparison to fathers of TD children (30%) who instead finished a vocational training.

In group C (3;0-3;5 years), approximately three times as many mothers (85%) and twice as many fathers (80%) of TD children than mothers (25.7%) and fathers (40%) of children with SLD attended grammar schools. Mothers and fathers of children with SLD went instead to general or intermediate secondary schools. In terms of professional training it seems that a substantially higher percentage of mothers (75%) and fathers (70%) of TD children achieved a university degree compared to mothers (20%) and fathers (13.3%) of children with SLD. However, since a high percentage of mothers (46.7%) and fathers (60%) of children with SLD refused to give information about their professional training, it remains unclear whether parents of TD children and children with SLD had a different educational background. For the interpretation of results it should be kept in mind that there were possible differences in parental education for the younger and the oldest groups.

2.3.8 Language therapy in the clinical sample

The second part of the parental questionnaire asked about children's past and current history of language therapy: *whether* a child had ever received language therapy and *how many* sessions a child had attended or was attending. No TD child in any age group had received language therapy at any point in her/his life. In the youngest age group, 6 of the 19 children with SLD (31.6%) had very recently started language therapy but no child had attended more than two therapy sessions. In the middle age group, 1 of the 11 children (9.09%) had attended 12 therapy sessions prior to taking part in the study. In the oldest age group, 7 of the 15 children (46.6%) were receiving language therapy. Of these, 2 children had had no more than five sessions, 2 children had attended 10 sessions and 3 children had received approximately 30 sessions.

2.3.9 Children excluded from the study

Sixteen TD children and children with SLD referred to the study by nursery teachers and health professions were excluded from the study for a variety of reasons.

Six children referred as TD children were excluded due to:

- a diagnosis of identifiable developmental disorder (1 boy)
- incorrect age (1 girl)
- German as second or third language (2 boys and 1 girl)
- non-cooperation, i.e. no participation in any language, general developmental or imitative assessment (1 boy)

Ten children referred as children with SLD were excluded due to:

- a diagnosis of adenoids and acute otitis media (2 girls), autism (1 boy) and mutism (1 girl)
- unintelligibility due to a severe phonetic-phonological disorder (1 boy)
- German as second language (1 boy)
- absence on the scheduled date for the second session (1 girl)
- concern of relatives about the assessments (1 girl)
- the impossibility of assessing twins separately when – according to the mother – they had never been separated throughout their life (2 boys).

2.4 Battery of imitation tasks

The novel imitation battery constructed for this research consisted of three main parts, Part 1: Postures and gestures (comprising five tasks), Part 2: Actions on objects (comprising three tasks, one with two subtasks) and Part 3: Verbal tasks (comprising three tasks). Table 14 provides an overview of the imitation battery. The following section describes the general administration procedure and the construction, material, administration, and scoring criteria of each individual task. Full protocols of the imitation battery can be found in the appendices, including all data and scoring sheets (see Appendix C.1–C.3) and detailed scoring criteria (see Appendix C.4).

Table 14: Overview of the imitation battery

<table>
<tr><th>Part 1:
Postures & gestures</th><th>Part 2:
Actions on objects</th><th>Part 3:
Verbal tasks</th></tr>
<tr><td>Facial postures
(3 items)</td><td rowspan="3">Common instrumental acts with familiar objects (10 items)

Subtask 1: Action details (8 items)
Subtask 2: Rational imitation (2 items)</td><td>Nonwords
(9 items)</td></tr>
<tr><td>Facial expressions
(2 items)</td><td rowspan="2">Words
(9 items)</td></tr>
<tr><td>Manual postures
(10 items)</td></tr>
<tr><td>Object related gestures
(4 items)</td><td>Common instrumental acts with unfamiliar objects (4 items)</td><td rowspan="2">Sentences
(20 items)</td></tr>
<tr><td>Conventional gestures
(4 items)</td><td>Pretend acts with substitute objects
(4 items)</td></tr>
</table>

2.4.1 General procedure

All imitation tasks were embedded in game-like contexts that were specifically designed to keep children at this young age engaged, and to elicit immediate responses with a minimum of verbal instructions. The general procedure allowed for two trials per test item. After the investigator was sure she had the child's full attention, she modelled the target item and then invited the child to act by saying: "Now you (do it)!" or "Now it's your turn!". If the child did not show any reaction within five seconds the investigator modelled the target item again, followed by a second invitation. Importantly, in all *nonverbal* trials each target item was demonstrated *twice* before the child was invited to act, whereas in all *verbal* trials each target item was demonstrated *once* before the child was invited to act. In total, then, children observed nonverbal items up to four times and verbal items up to two times. The administration of a second trial, nonverbal or verbal, did not affect scoring but was noted on the score sheet. As soon as the child started her/his response the instructor stopped modelling the target action and scored the response. When the child performed more than one imitation response, the first response to each item was scored unless the child spontaneously self-corrected herself/himself, in which case the self-corrected response was scored. Scores for individual items were summed to give a total score for each task. Practice items were administered at the beginning of the first posture and gesture block, and the tasks pretend acts with substitute objects, imitation of nonwords, and imitation of sentences. Where practice items were administered, the aim was to familiarise the child with the task. They were not scored and correct responses were not required to proceed to the test items. The administration of the whole battery took approximately 20-30 minutes.

2.4.2 Part 1: Postures and gestures

All target postures, gestures and expressions required the imitation of body movements. They did not involve objects and did not produce an observable functional outcome, and were therefore categorised as intention-sensitive (see section 1.1.4).

Manual posture-items did not convey conventional or symbolic meaning. The task comprised three hand movements and seven hand-to-body postures (i.e. hand movements towards different locations of the body). Movements involved one or both hands, and were directed towards ipsilateral and contralateral body parts, and towards the middle of the body. The level of difficulty ranged from simple early postures (e.g. grab your nose) to sophisticated and more complex postures (e.g. form a T-sign).

In contrast, gesture-items conveyed meaning. The conventional gesture task comprised four gestures which carry a culturally defined social-communicative function (e.g. waving for greeting). The object-related gesture task involved four pretend actions which symbolise characteristic features of the referent object and its use. Hands are used as pretend objects (e.g. hands as cushion) or as if employing an object (e.g. as if eating with spoon). For the full list of target items see Table 15.

Table 15: Postures, gestures and facial expressions

Facial postures & expressions	Manual postures	Gestures
Facial postures	Pat top of head with one hand	**Conventional gestures**
Open and close mouth	Grab nose	Waving for greeting
Protrude tongue	Pull one ear with one hand	Shake head for no
Close and open eyes	Pull both ears with both hands (ipsilateral)	Shrug shoulders
Facial expressions	Touch shoulder	Fingers to lips for quiet
Anger	Pat elbow	**Object related gestures**
Happiness	Lift one finger	Pretend to sleep (hands shaping a cushion)
	Form and open fist	Pretend to eat with a spoon
	Form T-sign	Pretend to drink from a bottle
	Pat both thighs with both hands	Pretend to throw a ball

The construction of posture and gesture tasks was based on research with TD children (Crais, Douglas, & Campbell, 2004; Erjavec & Horne, 2008; Gleissner et al., 2000), children with ASD (Beadle-Brown & Whiten, 2004; Beall, Moody, McIntosh, Hepburn, & Reed, 2008; Gernsbacher, Sauer, Geye, Schweigert, & Hill Goldsmith, 2008; Libby et al., 1997; McEwen, Happe, Bolton, Rijsdijk, Ronald, Dworzynski, & Plomin, 2007; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Rogers et al., 2003; Smith & Bryson, 2007; Stone et al., 1997; Vivanti et al., 2008) and children with SLI (Hill, 1998).

Prediction:

It was predicted that some children with SLD would have difficulty with these ISI tasks, since they are relatively reliant on sociocognitive capacities.

PRESENTATION

Postures, gestures and expressions were mixed and presented in two blocks, which were separated by other tasks to vary activities and so help to keep children engaged. The order of the two blocks was counterbalanced across participants (see section 2.4.5 and data sheet version A and B Appendix C.1-C.2).

Child and instructor were kneeling opposite each other on the floor. The instructor told the child: "I know a really funny game. It's easy. Look!". Then she modelled the practice item and instructed the child: "Now you. (Do what I do. Just try.)". After the child's response she praised the child and stated: "Great! I know something else!". She proceeded in the same way with all test items. The first six items of a block were administered to all children, but when a child did not respond to any of these six items, the block was discontinued and all remaining items were scored as non-compliance (0 points). When the child attempted at least one of the first six postures or gestures of a block, all test items in this block were administered.

SCORING

Facial postures and facial expressions

These were scored only for *attempt to imitate*. One point was awarded if the child attempted to move relevant parts of the face, and 0 points if the child refused, i.e. made no facial movement.

Scoring criteria did not differentiate accuracy of attempts to imitate since piloting revealed that it was not possible to reliably score facial postures and expressions in a more graduated way (see section 2.4.6). This scoring has implications for interpretation of results on these items.

Manual postures, conventional and object related gestures

These have clearer components allowing for reliable differentiation of attempts to imitate and therefore for scoring accuracy. To enable reliable application of scoring, full scoring criteria were drawn up describing each individual posture and gesture in detail and specifying which features of a target act needed to be produced by the child to achieve fully accurate performance (see Appendix C.4). Allowances were made for some developmental processes based on research investigating imitation skills in TD children at this age (Erjavec & Horne, 2008; Gleissner et al., 2000). For example, children were allowed to carry out the posture 'pull one ear' either with the ipsilateral or the contralateral ear.

- **Accurate**: 2 points.
  - *Manual postures*: The child reproduced the entire body movement as specified in terms of changes in posture and location.
  - *Conventional and object related gestures*: The child reproduced a comprehensible gestural act that represented without doubt a specific social function or the shape and use of an object.
- **Partial**: 1 point.
  - *Manual postures*: The child's response showed some similarities with the modelled target act in terms of chosen body parts and/or plane and direction of manner of movement (e.g. the child lifts more than one finger when reproducing the item 'lift index finger').
  - *Conventional gestures*: The child's response is a visible attempt to represent a specific social function but the gesture is inaccurate and/or the target content is uncertain (e.g. the child uses both hands to wave instead of one hand).
  - *Object related gestures*: The child's response is a visible attempt to establish a reference to the use of a target object but with inaccuracies in the representation of the object shape and/or its use (e.g. the child pretends to drink without representing the shape of a bottle).
- **Unrelated**: 0 points. The imitative response of the child shared no features with the modelled act.
- **Non-compliance**: 0 points. The child did not attempt to imitate the item.

2.4.3 Part 2: Actions on objects

COMMON INSTRUMENTAL ACTS WITH FAMILIAR OBJECTS

Main task

This comprised 10 simple and common instrumental acts with familiar objects (e.g. start police car; see Table 16). It was primarily designed to measure children's ability to achieve outcomes of instrumental acts.

Prediction: Common instrumental acts on familiar objects were categorised as outcome-sensitive and therefore relatively independent of sociocognitive capacities. All items were predicted to be carried out effortlessly by all participants.

Table 16: Instrumental acts on familiar objects

Method of presentation	Main task	Subtask 1*	Subtask 2
	Instrumental acts on familiar objects (outcome)	**Varied action details**	**Varied context**
Present game	Play xylophone (music)	Play forcefully or gently (style of movement)	----
	Start police car (car moves)	Press button with one finger or a fist (manner of movement)	----
	Greet dolphin (dolphin greeted)	Use falling or rising intonation (manner of intonation)	----
	Touch dolphin (dolphin touched)	Stroke or tap dolphin (manner of movement)	----
	Play music box (hear music)	Turn handle gently or forcefully (style of movement)	----
Mouse-house game	I Move mouse into house (mouse in house)	----	Door closed during presentation
	II Move mouse into house (mouse in house)	Mouse hops or slides (manner of movement)	----
	III Move mouse into house (mouse in house)	Use falling or rising intonation (manner of intonation)	----
	IV Move mouse into house (mouse in house)	----	Door open during presentation
	V Move mouse (mouse moves)	Mouse hops or slides (manner of movement)	----

* red = variation A; black = variation B

Subtask 1

Eight of the items in this task were further designed to measure children's ability to imitate various action details that were not necessary to achieve the outcome of the demonstrated act. Each item was presented in two different variations of manner or style, with half of each group receiving one variation and half receiving the other variation (see Table 16 and 2.4.5). Subtask 1 was based on methodology developed by Hobson & Hobson (2008), Hobson & Lee (1999), and Carpenter, Call and Tomasello (2005).

Research question: Based on empirical results of children with ASD (Hobson & Hobson, 2008; Hobson & Lee, 1999), this subtask was included to investigate whether children with SLD, like some children with ASD, would have difficulty imitating unnecessary action details. No prediction was made.

Subtask 2

Two items were in addition designed to measure children's ability to adapt their production to varied contexts, closely based on methodology used by Schwier et al. (2006). Children observed how the instructor made a toy mouse enter a toy house. Instead of using the door, the instructor used the unusual means of letting the mouse jump through the chimney in two different conditions. In the first condition, the door of the toy house was closed providing a rationale for using the chimney. In the second condition, the door was wide open but the demonstrator freely chose to use the chimney. In both conditions the door was open when the child was required to reproduce the act.

Based on the study with TD children (Schwier et al., 2006) children were expected to respond as follows:

- *First condition (door closed during demonstrator's presentation)*: Here, children were expected to infer that the demonstrator used the chimney because the door was closed. Once the door was open, children were expected to take the mouse through the door because there was no longer any reason to choose the chimney route.
- *Second condition (door open during demonstrator's presentation)*: Here, children were expected to infer that the demonstrator intended to choose an unusual means of entering the house, since the door was open during the demonstration, and that the unusual action was what they should imitate. Thus, children were expected to imitate the unusual action and to take the mouse through the chimney.

Research question: Based on empirical results of TD children (Schwier et al., 2006), this subtask was included to investigate whether some children with SLD would have problems adapting their imitative response based on possible rationales for the demonstrator's action, termed 'rational imitation'. No prediction was made.

Presentation

Target items were embedded in two games: the present game and the mouse-house game (see Appendix C.4). No discontinuation rules were applied.

In the **present game**, instructor and child were seated opposite each other on the floor. The instructor presented a box wrapped in gift paper. The box contained four objects that were invisible to the child (xylophone, police-car, dolphin and music-box). The instructor slowly opened the lid of the box without displaying the objects to the child and said: "You know what...I got a present. Let's see what's inside.

You can stay where you are, I'll show you everything". Then she took out the xylophone and stated: "Oh, a xylophone! It makes music. Look!" Checking eye contact with the child, she played the xylophone, either in an exaggeratedly gentle or forceful style. Afterwards she handed the beater to the child with the instruction: "Now you". She proceeded in a similar way with all objects (police car: "A police car. It drives"; greeting and touching dolphin: "Oh, a dolphin! Hello dolphin!"; music-box: "A music-box. It makes music").

In the **mouse-house game**, the instructor placed a toy-house and garden in front of her and invited the child to sit next to her. The instructor had three mice hidden in her pocket. After the child knelt next to her, she presented the house and highlighted the locked door ("A house. The door is locked."). **For item I**, she immediately produced some mouse sounds, took the green mouse out of her pocket, placed it in the starting position ("A mouse! Look what it's doing!"), and rolled it down the garden-path to the door. Arriving at the door the mouse paused, made two short forward motions towards the door (as if testing the door's state) and then jumped through the chimney into the house. The instructor then opened the door ("Now the door is open"), placed the mouse in the starting position and instructed the child ("Now you!"). **For item II**, she again produced some mouse sounds, presented a second mouse, placed it in the starting position and moved it down the path into the house, either in a hopping or sliding manner of movement. **For item III**, she repeated the previous action (Item II) but added the exclamation "hui" while moving the mouse down the path, either with a falling or rising intonation. **For item IV**, the instructor repeated the first test item (mouse jumps through chimney) but with the door now open. **For item V**, she put the house and the path away ("Bye bye house") and moved the last mouse that was hidden in her pocket ("Oh, I forgot one mouse!") over the garden (starting from the starting point), either in a hopping or sliding manner.

Scoring

The achievement of outcomes, reproduction of action details and rational imitation were scored separately.

Main task (outcomes): Children were awarded 1 point if they achieved the outcome and 0 points if they did not achieve the outcome or refused to imitate the modelled item.

Action details (Subtask 1):

- **Accurate**: 1 point. The child imitated the style or manner of movement demonstrated in the modelled act.
- **Incorrect**: 0 points. The child used a different style or manner of movement than demonstrated in the modelled act (e.g. used a whole hand instead of a finger to start the police-car).
- **Non-consideration**: 0 points. The child did not consider imitating the style or manner of movement.

Rational imitation (Subtask 2):

- **Rational**: 1 point. The child responded according to the expectation spelled out above, i.e. chose the door in the first condition, or the chimney in the second condition.
- **Irrational**: 0 points. The child did not respond according to the expectations spelled out above, i.e. chose the chimney in the first condition, or the door in the second condition.

COMMON INSTRUMENTAL ACTS WITH UNFAMILIAR OBJECTS

Each of the four common instrumental acts with *unfamiliar* objects demonstrated the manipulation of a novel object with a hidden effect (see Appendix C.4):

- shaking a dumbbell to evoke a giggly noise;
- pulling both sides of a bone apart to obtain a sticker;
- taking out a piece of rubber foam and moving the leaver of a light-box to evoke a flashing light;
- holding a present on its handle and pushing it upside down on the floor to evoke a squeaking noise.

Children had never seen or played with the objects before and were unaware of their function. To achieve an outcome, objects had to be manipulated according to a particular strategy. Specific causal links between object properties, particular actions and results were novel for children but they were based on familiar behavioural strategies such as moving a lever or shaking an object. The task was based on methodology developed by Meltzoff (1988a, 1988b), Hobson and Hobson (2008) and Hobson and Lee (1999).

Prediction: Like instrumental acts on *familiar* objects, instrumental acts on *unfamiliar* objects were categorised as outcome-sensitive, and it was predicted that children with SLD would have no difficulty with this task since it is relatively independent of sociocognitive capacities. However, empirical results of children with ASD (see section 1.2 and 1.3) raised the question whether the *unfamiliarity* of objects would influence children's performance.

Presentation

To administer the task, child and investigator were seated opposite each other on the floor. All test materials were stored in a little bag and were invisible to the child. The investigator showed the child the bag and said: "I brought another bag of toys for us. Right, what do we have?". To ensure that target acts were not part of children's spontaneous repertoire, the investigator took one object out of the bag and handed it to the child with the instruction: "Use this!". If the child did not perform an act similar to that about to be demonstrated, the investigator retrieved the object from the child, stated "I'll show you something" and performed the novel act with the object to cause the hidden effect. Then she handed the object back to the child with the instruction: "Now you". She proceeded in the same way with the remaining three test items. No discontinuation rules were applied.

Scoring

The imitation of the strategy (the means of the imitative act) and the causation of the hidden effect (the outcome of the imitative act) were scored separately.

Means:

- **Accurate**: 1 point. The child imitated the use of the object with the means demonstrated to produce the outcome.
- **Incorrect**: 0 points. The child's response showed inaccuracies in acting out the use of a novel object (e.g. the child held the body of the squeaking present instead of its handle) or shared no features with the modelled act.
- **Non-compliance**: 0 points. The child did not attempt to imitate the item.

Outcome: Children were awarded 1 point if they achieved the outcome and 0 points if they did not achieve the outcome.

PRETEND ACTS WITH SUBSTITUTE OBJECTS

This task comprised four pretend acts with counterfunctional substitute objects, i.e. real objects with clear instrumental functions were used to represent a different object with a different function. All substitute objects conveyed symbolic meaning and shared visual similarities with the real objects:

- pretend to brush hair with a spoon;
- pretend to drink from a miniature hat;
- pretend to phone with a banana; and
- pretend to brush teeth with a pencil.

The task was based on methodology developed by Chiat & Roy (2008), Libby et al. (1997) and Smith and Bryson (2007).

Research question: Pretend acts with substitute objects are on the cusp between outcome-sensitive and intention-sensitive target acts, since acts involve real objects without resulting in singular functional outcomes. The task was included to explore whether children with SLD would have difficulties to imitate this particular target act. Since the task was classified as hybrid measure, it did not lead to a clear prediction.

Presentation

Pretend acts were elicited with the help of a bag to hide the substitute objects and a foldable tower (see Appendix C.4). The instructor displayed the tower between the child and herself, slowly opened the little bag with the hidden substitute objects and said: "Uh, I brought another bag of toys for us. We are going to do funny things with them. Look!". She took the practice item, a sponge, out of the bag and placed it on her head. Then she handed the sponge over to the child with the instruction: "Now you". The instructor then encouraged the child to throw the substitute object in the tower, pointing towards the tower and saying: "And now in the tower." She proceeded in the same way with each test item. The task was closed by lifting the tower and asking the child to help put away the toys. No discontinuation rules were applied.

Scoring

- **Accurate**: 2 points. The child used the substitute object in the demonstrated counterfunctional way.
- **Partial**: 1 point.
  - *Inaccurate*: The child's response showed inaccuracies in the use of the substitute object (e.g. the child held the pen with both hands instead of one hand while pretending to brush teeth).
  - *Conventional*: The child used the substitute object in its conventional way (e.g. drew on a piece of paper with the pencil).
- **Unrelated**: 0 points. The child's response shared no features with the modelled act.
- **Non-compliance**: 0 points. The child did not attempt to imitate the demonstrated item or threw the object into the tower without attempting to imitate the item.

2.4.4 Part 3: Verbal tasks

Three verbal tasks were presented in Part 3: The imitation of nonwords, words and sentences (see Table 14). All verbal imitation tasks were based on the ERB (Seeff-Gabriel et al., 2008).

NONWORDS AND WORDS

The nonword and word tasks comprised nine items each, with two nonword practice items (see Table 17). The German real words included were high frequency, semantically familiar and contained early acquired phonemes (Fox & Dodd, 1999). They were equally divided in length between one-, two- and three-syllable items. Since 90% of two-syllable words in German are trochees and only 10% are iambs, test items with two syllables solely included the trochaic pattern of primary stress – post stress (Höhle & Weissenborn, 2000). Stress was more varied in the three syllable items. Nonwords were created by reversing or transposing consonants, changing most vowels and adjusting the voicing of real words (e.g. /ba'na:nə/ -> /nu'nu:bə/, see Table 17). They obeyed phonotactic constraints of German words. Word and nonwords were therefore of identical prosodic structure and included a systematic range of prosodic patterns. Further, they were phonologically matched in terms of consonant complexity and phoneme inventory.

Table 17: List of phonologically matched word and nonword targets with stress patterns

Words	Transcription	Nonwords	Transcription	Stress pattern
Practice items				
		Lup	/lʊp/	
		Du:fa	/'du:fɐ/	Primary stress – post stress
1 syllable				
Bett (bed)	/bɛt/	Tup	/tʊp/	
Lied (song)	/li:t/	Do:l	/do:l/	
Baum (tree)	/baʊ̯m/	Meip	/maɐ̯p/	
2 syllables				
Leiter (leader)	/'laɐ̯tɐ/	Tüla	/'ty:lɐ/	Primary stress – post stress
Wippe (seesaw)	/'wɪpə/	Powe	/'po:və/	Primary stress – post stress
Nudel (noodle)	/'nu:dəl/	Di:nel	/'di:nəl/	Primary stress – post stress
3 syllables				
Ameise (ant)	/'a:maezə/	A:sume	/'a:zʊmə/	Primary stress – post stress - secondary stress
Banane (banana)	/ba'na:nə/	Nunube	/nu'nu:bə/	Pre stress – primary stress – post stress
Elefant (elefant)	/e:lə'fant/	Efolint	/e:fo:'lɪnt/	Secondary stress – post stress – primary stress

Presentation

The nonword task was presented before the word task, and practice items were only given at the beginning of the nonword task.

Nonwords were elicited with the help of a 'monster-house', a toy-house with many doors behind which pictures of different unfamiliar fantasy creatures were hidden (see Appendix C.4). Child and instructor were seated opposite each other on the floor. The instructor introduced the monster-house: "This is my monster-house. In it live very friendly monsters. They get out when you say their name". While pointing to the door of the first 'practice-item-monster', the instructor stated: "Look, here lives /'du:fɐ/". Then she called the monster by saying its name (/'du:fɐ/), opened the door, greeted the monster (hello /'du:fɐ/) and closed the door again. She instructed the child: "Now you! (Say) /'du:fɐ/". After the child said the nonword, 'the monster' opened the door and greeted the child with her/his name. Then the instructor proceeded with the second practice item ("Great, let's try another door. This is ... (break) .../lʊp/. Now you... (break)... /lʊp/."). After the administration of both practice items, the instructor introduced each item by pointing at one door and saying no more than the monster's name.

Words were elicited with the help of a magic glittery wand (see Appendix C.4). At the beginning of the task the instructor showed the child a magic wand and let her/him explore it for a while. After the child handed it back, the instructor told the child: "Now we are going to perform some magic! First me, then you". Then she swung the wand and produced the first word at the same time. She then handed the wand over to the child with the instruction: "Now you". She proceeded in the same way with all test items.

The first five test items of both tasks were administered to all children but if the child did not respond to any of these five items, the task was discontinued and all remaining items were scored as non-compliance (0 points). However, if the child attempted at least one of the first five nonwords or words, all test items of the task were administered.

Scoring

- **Accurate**: 1 point. The child reproduced the entire sequence of phonemes of a word or nonword in the correct order with no additions (with allowances: see below).
- **Incorrect**: 0 points. The child attempted to imitate the item but did not produce all and only the target phonemes in the correct order.
- **Non-compliance**: 0 points. The child did not attempt to imitate the item.

Allowances were made for all developmental phonological processes but not for delayed and/or unusual phonological processes (regardless whether these were systematic or not). The decision whether a phonological process was typical, delayed or unusual at a certain age was based on (Fox & Dodd, 1999).

SENTENCES

The sentence imitation task comprised two practice and 20 test items (see Table 18).

Test items were phrases and sentences ranging from two to six words in length. They were designed to be informative about children's morphosyntactic competence and measured this at three different levels:

- Level 1: Two-word-phrases and sentences with some inflections
- Level 2: Simple sentence structures
- Level 3: More complex sentence structures with additional elements.

Table 18: Phrase and sentence targets with English translation

German sentence		English translation
Practice items		
2 words	ein Hut	a hat
	Anna malt.	Anna is painting.
Level 1		
2 words	Bonbon essen	eating sweet
	Mamas Bett	Mother's bed
	Schuhe aus!	Take (your) shoes off!
	Lass das!	Stop it!
	Lena rennt.	Lena is running.
	Ich baue.	I am building.
Level 2		
3 words	Der Hund bellt.	The dog barks.
	Sie hat gebadet.	She had a bath.
4 words	Die Blumen sind schön.	The flowers are pretty.
	Du malst einen Mann.	You are painting a man.
5 words	Er hat den Teddy gefunden.	He found the teddy bear.
	Die Babys trinken ihre Milch.	The babies are drinking their milk.
Level 3		
4 words	Ich singe kein Lied.	I am not singing a song.
5 words	Tom klettert auf einen Baum.	Tom climbs on a tree.
	Die Kinder mögen kleine Enten.	Children like little ducks.
	Den Hasen füttert die Oma.	The bunny, granny is feeding.
	Anna wird von Jan geküsst.	Anna is kissed by Jan.
6 words	Heute geht sie in den Laden.	Today she goes (in) to the shop.
	Er gibt dem Jungen das Buch.	He gives the book to the boy.
	Sie weint, weil sie traurig ist.	She cries because she is sad.

Test items included the following syntactic, morphological and morphosyntactic aspects:

- a range of different constituents (nominal, verbal and prepositional phrases)
- a range of personal and possessive pronouns differing in gender, number and case
- a range of definite and indefinite determiners differing in gender, number and case
- main, auxiliary and modal verbs differing in person, tense and number
- a range of verb types and verb structures including one double-object construction
- an adjective in attributive position and an adjective in predicate position
- a negation
- a topicalised accusative object and time adverb both of which induce subject-verb inversion
- a passive construction
- a sub-clause

Phrases and sentences were made up of a range of content words, function words and inflections. Content words were high frequency, semantically familiar, short, and contained early acquired phonemes and simple phonotactic structures. Choice of words was based on research analysing the age-appropriate lexicon of 20-25-month-old TD children (Von Suchodoletz, 2010).

Presentation

Sentences were elicited with the help of a puppet. Child and instructor were seated opposite each other on the floor. The child could either choose a raven or frog puppet to play with them. The instructor told the child: "This is Mr. Raven/Frog! He knows a good game. You say everything he says. First it's his turn than it's your turn". Then the instructor produced each item, starting with the practice items. If the child did not respond spontaneously the instructor said: "Now you". Test items of Level 1 were administered to all children, but if the child did not respond to any of these six items the task was discontinued and all remaining items were scored as non-compliance (0 points). However, if a child attempted at least one sentence at Level 1, all items of Level 2 were administered. The same procedure was applied for Levels 2 and 3.

Scoring

- **Accurate**: 1 point. The child reproduced the entire sentence accurately with all morphemes in correct order (with allowances for phonological processes, see below).
- **Incorrect**: 0 points. The child attempted to reproduce the item but did not produce all target morphemes in the correct order.
- **Non-compliance**: 0 points. The child did not attempt to imitate the item.

In this case, allowances were made for all developmental phonological processes (whether they were systematic or not) and for all *systematic* delayed and/or unusual phonological processes. The decision whether a phonological process was typical, delayed or unusual at a certain age was based on (Fox & Dodd, 1999).

2.4.5 Order of presentation

The imitation battery alternated between postures and gestures, actions on objects and verbal tasks. To assess fatigue or practice effects on performance, nonverbal tasks were presented in two different orders, represented in data sheets A and B in Table 19 below (see also Appendix C.1 & C.2). The following aspects were counterbalanced between A and B:

1. As described in section 2.4.2, all posture and gesture items of Part 1 were divided into two separate sets (Block 1 & Block 2), which were presented in opposite orders in A and B.
2. As described in section 2.4.3, instrumental acts on familiar objects were presented in two different manners or styles (Subtask 1: action details), but only one was demonstrated to each participant, participants receiving data sheet A observed version A of action details, and those receiving data sheet B observed version B.
3. The task instrumental acts on unfamiliar objects and the task pretend acts on substitute objects were presented in opposite orders in data sheet A and B.

The two verbal tasks were always presented in the same order (nonwords and words before sentences), but these were separated by different nonverbal tasks in data sheets A and B.

Participants were randomly allocated to either data sheet A or B, separately for the typical and clinical sample and for each age group.

Table 19: Data sheets A and B

A		B	
Subtasks 1: action details Version **A**	Instrumental acts on familiar objects **(Mouse-house game)**	**Subtasks 1: action details** Version **B**	Instrumental acts on familiar objects **(Mouse-house game)**
Postures & gestures **(Block 1)**		Postures & gestures **(Block 2)**	
Subtasks 1: action details Version **A**	Instrumental acts on familiar objects **(Present game)**	**Subtasks 1: action details** Version **B**	Instrumental acts on familiar objects **(Present game)**
Postures & gestures **(Block 2)**		Postures & gestures **(Block 1)**	
Instrumental acts on unfamiliar objects		Pretend acts on substitute objects	
Nonwords & words		Nonwords & words	
Pretend acts on substitute objects		Instrumental acts on unfamiliar objects	
Sentences		Sentences	

2.4.6 Pilot studies

LONDON: NONVERBAL TASKS

The aim of the piloting in London was to test the feasibility of the novel nonverbal imitation battery. More specifically the pilot study sought to determine:

- the feasibility and effectiveness of individual tasks and materials;
- the feasibility of administration time; and
- the reliability of scoring criteria.

Eight TD English-speaking children aged 2;0-3,5 years were recruited in the London area through colleagues at City University. All children were assessed at their family home once parents had returned signed consent forms. Piloting in London was carried out in two phases within a period of six months (August 2009 to January 2010).

Table 20: Order of nonverbal tasks in the original battery (pilot study) and the modified battery (main study)

Original order of nonverbal subtasks	Modified order of nonverbal subtasks
Instrumental tasks on familiar objects plus Subtasks 1 & 2 **(Mouse-house game & present game version A or B)**	Instrumental acts on familiar objects plus Subtask 1 & 2 **(Mouse-house game A or B)**
	Posture & gestures (Block 1 or 2)
Postures & gestures (Block 1, 2 or 3)	Instrumental acts on familiar objects plus Subtask 1 **(Present game A or B)**
Instrumental acts on unfamiliar objects or pretend acts on substitute objects	Posture & gestures (Block 1 or 2)
Postures & gestures (Block 1, 2 or 3)	Instrumental acts on unfamiliar objects or pretend acts on substitute objects
	[Words and nonwords]
Instrumental acts on unfamiliar objects or pretend acts on substitute objects	Instrumental acts on unfamiliar objects or pretend acts on substitute objects
Postures & gestures (Block 1, 2 or 3)	[Sentences]
Instrumental tasks on familiar objects plus Subtasks 1 & 2 **(Mouse-house game and present game version A or B)**	

The following aspects were modified based on outcomes of the pilot study:

- **Reduction and reordering of items**:
  - The original design comprised more posture and gesture items than the main study and items were organised in three instead of two blocks (see Table 20). Piloting revealed that children were happy to participate in two blocks but less willing by the third. Therefore, two manual postures (pull one ear contralaterally and pull both ears contralaterally) and one facial expression (astonished face) were removed, and all remaining postures, gestures and expressions were reorganised in two instead of three blocks.

- In the original design, all instrumental acts with familiar objects (mouse-house game and present game) were presented twice, first in one manner or style and then later in the other (e.g. first: play xylophone gently then play xylophone forcefully; see Table 16 and Table 20). Piloting revealed that some children became distracted or tired when the mouse-house and present were presented a second time. Therefore, each child in the main study was presented with only one version of details (either play xylophone gently or play xylophone forcefully), so that the mouse-house game and the present game were only administered once instead of twice (see section 2.4.5). In addition, two of the original items (shaking a rattling egg with tiny or wide movement and driving a car slowly or quickly) were removed since the contrast between the two manners of movement was not clear enough for reliable scoring.
- Two instrumental acts on unfamiliar objects (opening a cat-ball to get a sticker and tugging a jar to retrieve a gummibear) turned out to be motorically and cognitively too difficult for some children and were removed from the main study. To replace these items, two new items were added: squeaking present and light-box.

- **Change of items**: In the original design, details of the instrumental act 'starting a police car' were acted out using one finger versus a whole hand. The manner of movement 'using a whole hand' was changed to 'using a fist', since the contrast 'finger versus fist' was found to be clearer than the original contrast 'finger versus hand' and therefore easier to score.
- **Change of scoring criteria**: In the original version, criteria for scoring facial postures and expressions not only differentiated between pass (attempt) and fail (refusal) but in addition considered partial and unrelated imitation errors. Piloting revealed that it was not possible to judge reliably whether an expression such as anger or a posture such as closing your eyes was partially or completely accurate. Therefore, criteria for scoring facial postures and expressions were simplified in that they only differentiated between attempt and refusal.

In each task where items were eliminated, the remaining items were judged to be feasible and informative.

BONN: VERBAL TASKS AND FINAL ORDER

Since all verbal tasks were in German the whole revised battery including all nonverbal and verbal tasks was piloted before the start of the main study in Bonn with three German-speaking children between 2;0-3;5 years (one child in each age range). No issues arose in the administration of the imitation battery, therefore no further modifications were made.

2.5 Procedure

2.5.1 Assessment procedure

Once parents had returned a signed consent form, the researcher contacted them to thank them for their cooperation and to make the necessary arrangements for their child to be seen for the first assessment. A questionnaire on background information was handed in person to all participating parents and returned to the researcher directly or to a nursery teacher. Each child was seen individually for two to three sessions lasting 30-45 minutes. Test sessions were carried out in a quiet room at the child's nursery, clinic or home. Accordingly, times for testing were arranged with clinicians, nursery teacher or parents. The majority of typical children were assessed at their nursery unless parents specifically requested testing at their family home. A parent or nursery teacher could attend the test sessions if they and/or the child wished. The order of background assessments, imitation tasks and additional language measures was fixed for each age range in the typical and clinical samples, starting with the background assessments (see Table 21). At the end of each session each child could choose and keep a sticker from the treasure chest.

Table 21: Order of assessments according to group and age (A=2;0-2;5 years; B=2;6-2;11 years; 3;0-3;5 years)

<table>
<tr><th rowspan="2">Age</th><th colspan="3">Typical sample</th><th colspan="3">Clinical sample</th></tr>
<tr><th>Session 1</th><th>Session 2</th><th>Session3</th><th>Session 1</th><th>Session 2</th><th>Session 3</th></tr>
<tr><td rowspan="2">A</td><td rowspan="2">SETK-2
all subtests</td><td>Imitation
battery</td><td rowspan="2">---</td><td rowspan="2">SETK-2
all subtests</td><td>Imitation
battery</td><td rowspan="2">---</td></tr>
<tr><td>ET 6-6</td><td>ET 6-6</td></tr>
<tr><td rowspan="2">B</td><td>SETK-2
all subtests</td><td>Imitation
battery</td><td rowspan="2">---</td><td>SETK-2
all subtests</td><td>Imitation
battery</td><td rowspan="2">PDSS
subtests noun
and verb
comprehension</td></tr>
<tr><td>BAS II</td><td>ET 6-6</td><td>BAS II</td><td>ET 6-6</td></tr>
<tr><td rowspan="2">C</td><td>SETK-3
both subtests</td><td>PDSS
subtest noun
production</td><td>Imitation
battery</td><td>SETK-3
both subtests</td><td>PDSS
subtest noun
production</td><td>Imitation
battery</td></tr>
<tr><td>PDSS
subtests noun
and verb
comprehension</td><td>BAS II</td><td>ET 6-6</td><td>PDSS
subtests noun
and verb
comprehension</td><td>BAS II</td><td>ET 6-6</td></tr>
</table>

(SETK-2/3: Sprachentwicklungstest für zweijährige/dreijährige Kinder; PDSS: Patholinguistische Diagnostik bei Sprachentwicklungsstörungen, BAS II: British Ability Scales II; ET 6-6: Entwicklungstest 6-6)

2.5.2 Video recording, data entry and storage

To check reliability of administration and scoring, data collection was video recorded if parents gave permission (Panasonic digital video camera NV-GS 120 3CCD 1.7 mega pixel). The majority of parents gave permission to video record assessments. If parents did not give permission, responses were scored online.

Each child was allocated an encrypted code which was used on all paper and electronic data files and the list of names and codes was kept on a password protected electronic document. Anonymised data were entered into the Statistical Package for the Social Sciences (SPSS) version 17 and 19. Password protection was used for all computer files. The anonymous assessment forms and video tapes were kept in a locked cabinet at City University. Consent forms, and name and address details were kept securely and separately from the main database, assessment forms and video tapes.

2.5.3 Feedback to parents, nurseries and clinicians

After the final test session, an individual report about the child's language profile was written for each child with SLD. One copy was sent to the family of the participating child and another copy was sent to the referring paediatrician, SLT or phoniatrician. Fourteen children who were referred with problems by nursery teachers had not been previously identified with language problems. In all cases, a meeting with a parent and a nursery teacher was arranged to provide appropriate support and information. Parents were either advised to monitor a child's development until a specified age or to make contact with a local SLT practice which then undertook intervention. All families of participating TD children and their referring nursery teacher received a feedback letter confirming the child's age-appropriate and typical process of language acquisition. Nursery staff and clinicians were given small presents at the end of the data collection period to thank them for their cooperation. After the data had been analysed a report of the research project's findings was sent to all participating institutions and families.

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3 Results

Data was analysed using the Statistical Package for the Social Sciences (SPSS) version 17 and 19.

3.1 Construction of composites

The imitation battery comprised 11 tasks (one with two subtasks) with maximum scores ranging from 2-20. Of these tasks, eight formed four conceptually related pairs of tasks measuring aspects of nonverbal and verbal imitation (see section 2.4). These pairs were considered for combination into composites. Table 22 provides descriptive statistics for scores on each of these eight measures in the typical and clinical samples.

Table 22: Raw scores of separate imitation measures before creating composite scores

Planned composite	Separate measures	Max score	Typical (n=60)		Clinical (n=45)	
			Mean	SD	Mean	SD
Pair 1: Facial postures and expressions	Facial postures	3	2.85	0.61	1.24	1.35
	Facial expressions	2	1.90	0.44	0.69	0.87
Pair 2: Instrumental acts on unfamiliar objects	Means	4	3.62	0.59	3.33	0.74
	End-results	4	3.72	0.52	3.49	0.66
Pair 3: Gestures	Object related gestures	8	6.80	1.59	2.91	3.24
	Conventional gestures	8	7.38	1.53	3.24	3.52
Pair 4: Word and nonwords	Nonwords	9	6.68	2.10	2.51	2.98
	Words	9	7.92	1.68	2.24	2.63

To check assumed relations between the four pairs of measures, Pearson's product-moment correlations were conducted between raw scores of each pair, separately for the typical and clinical samples and controlling for children's age.

Table 23: Relations between pairs of imitation measures (controlled for age)

Measure x Measure	Typical sample (n = 60)	Clinical sample (n = 45)
Facial postures x Facial expressions	.956***	.767***
Means x End-results (instrumental acts on unfamiliar objects)	.488***	.562***
Object related gestures x Conventional gestures	.938***	.725***
Nonwords x Words	.643***	.740***

As can be seen in Table 23, statistical analysis yielded significant moderate to strong associations between all pairs of measures, validating the construction of the four theoretically motivated composites. Due to this compositing of measures, the imitation battery yielded seven tasks: 1) Facial postures/expressions, 2) manual postures, 3) gestures, 4) instrumental acts with familiar objects (with two subtasks), 5) instrumental acts on unfamiliar objects, 6) words-nonwords, 7) sentences.

3.2 Inter-rater reliability

Inter-rater reliability was considered for each task of the imitation battery. An experienced SLT was familiarised with the scoring criteria in one training session with the instructor (see Appendix C.4). Blind to the status of children, the SLT watched video-recordings of the administration of the imitation battery and independently rescored 6 TD children and 5 children with SLD (10.47% of the collected data). Cronbach's Alpha (Cronbach, 1951) was then used as a measure of reliability to determine the level of agreement between the two raters on the raw scores for each task. An alpha value between .82 and 1.0 was obtained for the individual tasks of the imitation battery and a total alpha value of .90 was obtained for the total sum of scores for all tasks. This is considered to be a good to excellent level of agreement (George & Mallery, 2011) and validates the scoring criteria developed for the imitation battery.

3.3 Order effects

The nonverbal imitation tasks were run in two orders (A and B) to assess fatigue or practice effects on performance (see section 2.4.5). To determine whether the order of tasks biased children's imitation performance, Mann-Whitney-U tests were used to compare results of order A versus B for the typical and clinical samples, corresponding to the outcome measures used for further analyses. Results of all five comparisons are shown in Table 22. As can be seen, results revealed no order effects in any comparison, either for the typical or clinical samples. Therefore, order of presentation was not taken into account in any further analyses.

Table 24: Results of Mann-Whitney-U tests comparing results of order A versus B

	Typical sample (n=60)		Clinical sample(n=45)	
	z	p	z	p
Total scores of both gesture/posture blocks	-1.48	ns	-0.57	ns
Instrumental acts on unfamiliar objects	-1.34	ns	-0.48	ns
Pretend acts	-0.93	ns	-1.13	ns
Instrumental acts on familiar objects (outcomes)	-0.49	ns	-1.05	ns
Subtask 1: Action details	-1.47	ns	-0.96	ns

3.4 Nonverbal imitation

The first aim of this study was to compare the performance of groups of TD children and children with SLD on a range of novel nonverbal imitation tasks categorised as intention-sensitive, outcome-sensitive and hybrid measures to investigate whether and which nonverbal imitation behaviours would significantly differentiate groups across three age ranges.

It was expected that some children with SLD would have difficulty with nonverbal imitation tasks categorised as intention-sensitive, since measures were assumed to indicative of sociocognitive capacities, and it was expected that the clinical sample would include children with such deficits. In contrast, it was expected that nonverbal imitation tasks identified as outcome-sensitive would be no more challenging for children with SLD than for TD children, since measures were relatively independent of sociocognitive capacities.

Tests of normality (Kolmogorov-Smirnov test) and homogeneity (Levene's test) were carried out. Due to violations of the underlying assumptions of normality and homogeneity in most data-sets, planned analyses of variance could not be calculated. Instead, two-tailed Mann-Whitney-U tests were used for significance testing. An α-level of .05 was selected at which an effect was accepted as statistically significant. To calculate effect sizes, z-scores were converted into the effect size estimate r using the following equation (Field, 2005):

$$r = \frac{Z}{\sqrt{N}}$$

Based on Cohen's (1992) widely accepted suggestions, a correlation coefficient of

- .10 was considered as a small effect;
- .30 was considered as a medium effect; and
- .50 was considered as large effect.

Although assumptions for parametric analyses were violated in most data-sets, analysis of variance was used to investigate potential interactions between the factors group and age for results of each task, interpreted with caution when main effects were supported by nonparametric analyses. According to Field (2005), analyses of variance are considered to be fairly robust to violations of normality.

3.4.1 ISI measures: Postures and gestures

The first part of the imitation battery, postures and gestures, included three different tasks: facial postures/expressions, manual postures and gestures. All tasks were categorised as intention-sensitive (ISI measures). Manual posture-items did not convey conventional or symbolic meaning whereas gesture-items did convey intended meaning.

FACIAL POSTURES/EXPRESSIONS

Table 25 provides the descriptive and inferential statistics and Figure 2 the boxplots for facial posture/expression scores in the typical and clinical samples according to age group. A boxplot is a graphical representation of some important characteristics of a data-set. At the centre of the plot is the median, which is surrounded by a box, the top and bottom of which are the limits within which the middle 50 % of observations fall (the interquartile range). At the top and bottom of the box are two whiskers which extend to the minimum and maximum score respectively. Outliers are indicated by a dot, extreme outliers by an asterisk.

Table 25: Descriptive and inferential statistics of facial posture/expression raw scores according to group and age

Group		n	Median	SD	Range (max = 5)		z	p	r
					Min	Max			
A 2;0-2;5	Typical	20	5.0	1.71	0	5	-4.54	.001	-.72
	Clinical	19	0.0	1.54	0	5			
B 2;6-2;11	Typical	20	5.0	0.00	5	5	-5.33	.001	-.95
	Clinical	11	0.0	1.53	0	4			
C 3;0-3;5	Typical	20	5.0	0.00	5	5	-2.74	.010	-.46
	Clinical	15	5.0	2.08	0	5			

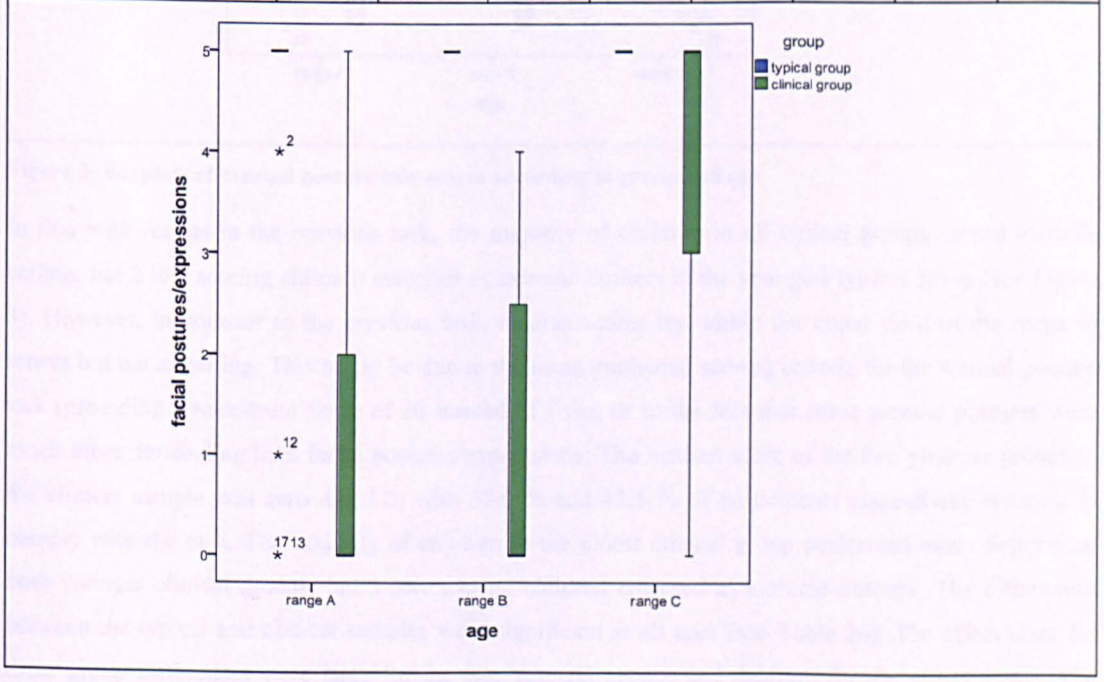

Figure 2: Boxplots of facial posture/expression raw scores according to group and age

As can be seen in Figure 2, ceiling effects were evident in the two older groups in the typical sample. The majority of children in the youngest typical group were also at ceiling, but 3 low scoring children emerged as extreme outliers. Here it is important to keep in mind that scoring criteria for the facial postures/expressions differentiated only attempt versus refusal to imitate an item, providing a maximum score of five (see section 2.4.2). Thus, ceiling effects were much more likely for the facial postures/expressions than for the other posture and gesture tasks. The median score of the two younger groups in the clinical sample was zero, with 68.4 % and 63.6 % of participants respectively refusing to comply with the task. The majority of children in the oldest clinical group performed much better than both younger clinical groups. The differences between the typical and clinical samples were significant at all ages (see Table 25). The effect sizes for these group differences were large for the two younger groups and medium for the oldest group. The scores of the two younger age groups in the typical sample differed from each other ($z = -2.08$, $p < .05$), as did the scores of the two older age groups in the clinical sample ($z = -2.98$, $p < .05$). As might be expected from the ceiling and floor effects noted above, no significant age differences were found between the two older age groups in the typical sample or between the two younger age groups in the clinical sample.

MANUAL POSTURES

Table 26 provides the descriptive and inferential statistics and Figure 3 the boxplots for manual posture scores in the typical and clinical samples according to age group.

Table 26: Descriptive and inferential statistics of manual posture raw scores according to group and age

Group		n	Median	SD	Range (max = 20)		z	p	r
					Min	Max			
A 2;0-2;5	Typical	20	16.0	5.20	0	19	-4.45	.001	-.71
	Clinical	19	0.0	5.08	0	14			
B 2;6-2;11	Typical	20	16.0	1.42	14	18	-4.52	.001	-.81
	Clinical	11	1.0	5.92	0	14			
C 3;0-3;5	Typical	20	18.0	1.31	14	19	-2.35	.050	-.39
	Clinical	15	16.0	7.07	0	19			

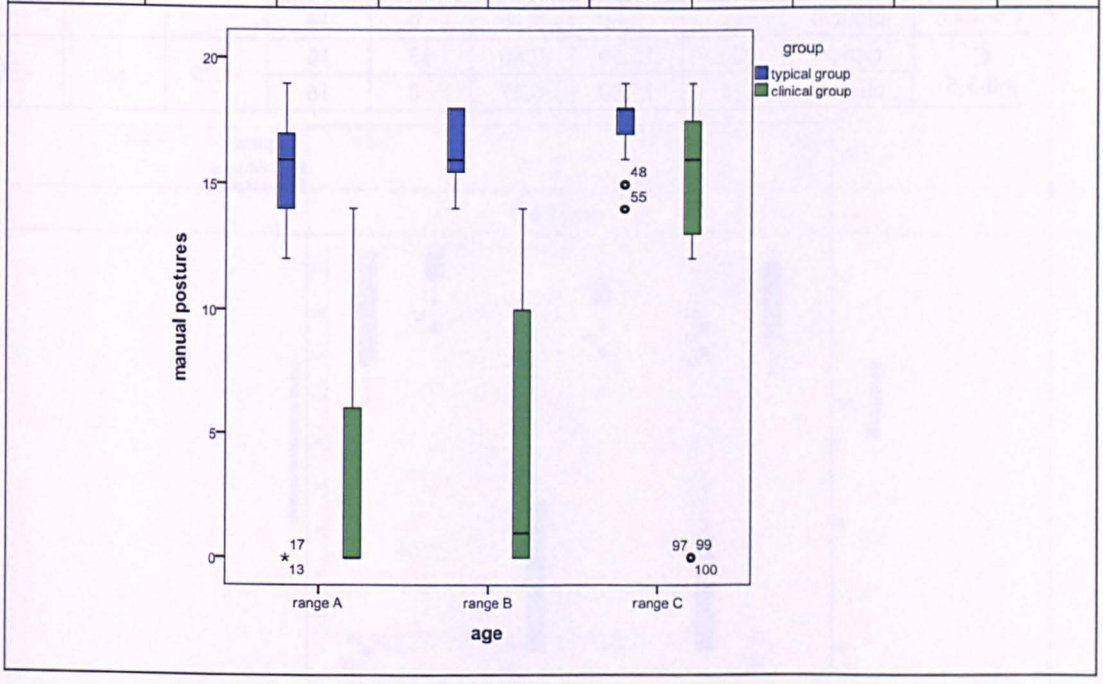

Figure 3: Boxplots of manual posture raw scores according to group and age

In line with results in the previous task, the majority of children in all typical groups scored towards ceiling, but 2 low scoring children emerged as extreme outliers in the youngest typical group (see Figure 3). However, in contrast to the previous task, median scores lay within the upper third of the range of scores but not at ceiling. This might be due to the more graduated scoring criteria for the manual posture task (providing a maximum score of 20 instead of five), or to the fact that some manual postures were much more demanding than facial postures/expressions. The median score of the two younger groups in the clinical sample was zero and 1.0, with 52.6 % and 45.5 % of participants respectively refusing to comply with the task. The majority of children in the oldest clinical group performed much better than both younger clinical groups, but 3 low scoring children emerged as extreme outliers. The differences between the typical and clinical samples were significant at all ages (see Table 26). The effect sizes for these group differences were large for the two younger groups and medium for the oldest group. The scores of the two older age groups in the typical ($z = -2.70$, $p < .01$) and clinical sample ($z = -2.85$, $p < .01$)

differed from each other. No significant age differences were found between the two younger age groups in the typical or clinical samples.

GESTURES

Table 27 provides the descriptive and inferential statistics and Figure 4 the boxplots for gesture scores in the typical and clinical samples according to age group.

Table 27: Descriptive and inferential statistics of gesture raw scores according to group and age

Group		n	Median	SD	Range (max = 16)		z	p	r
					Min	Max			
A 2;0-2;5	typical	20	14.00	4.63	0	16	-4.50	.001	-.72
	clinical	19	0.00	4.73	0	13			
B 2;6-2;11	typical	20	14.50	1.09	12	16	-4.20	.001	-.75
	clinical	11	2.00	5.16	0	14			
C 3;0-3;5	typical	20	15.50	0.86	13	16	-1.79	ns	-.30
	clinical	15	15.00	6.27	0	16			

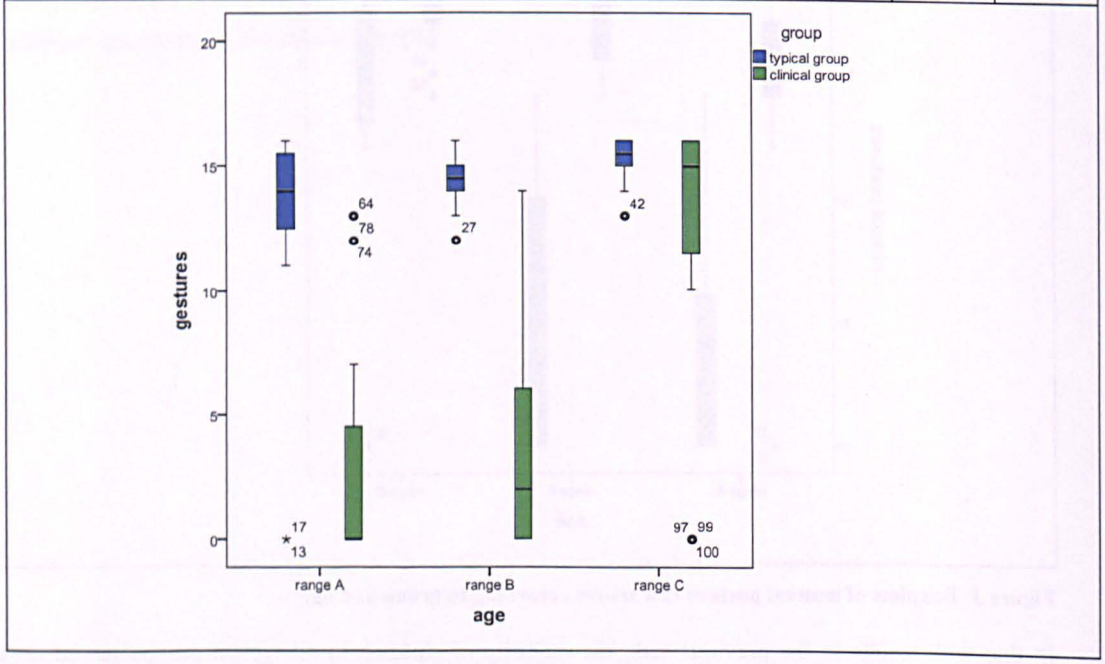

Figure 4: Boxplots of gesture raw scores according to group and age

As can be seen in Figure 4, the majority of children in all typical groups scored close to ceiling, but 2 low scoring children emerged as extreme outliers in the youngest typical group. In contrast, the median score of the two younger groups in the clinical sample was zero and 2.0, with 63.2 % and 36.4 % of participants respectively refusing to comply with the task. The majority of children in the oldest clinical group performed much better than both younger clinical groups, but 3 low scoring children emerged as outliers. The differences between the typical and clinical samples were significant for the two younger groups but not for the oldest group (see Table 27). The effect sizes for these group differences were large for the two younger groups and medium for the oldest group. The scores of the two older age groups in the typical ($z = -2.72$, $p < .01$) and clinical ($z = -2.72$, $p < .01$) sample differed from each other. No significant age differences were found between the two younger age groups in the typical or clinical samples.

SUMMARY POSTURES AND GESTURES

Figure 5 provides line graphs showing estimated marginal means for facial posture/expression, manual posture and gesture scores in the typical and clinical samples according to age group.

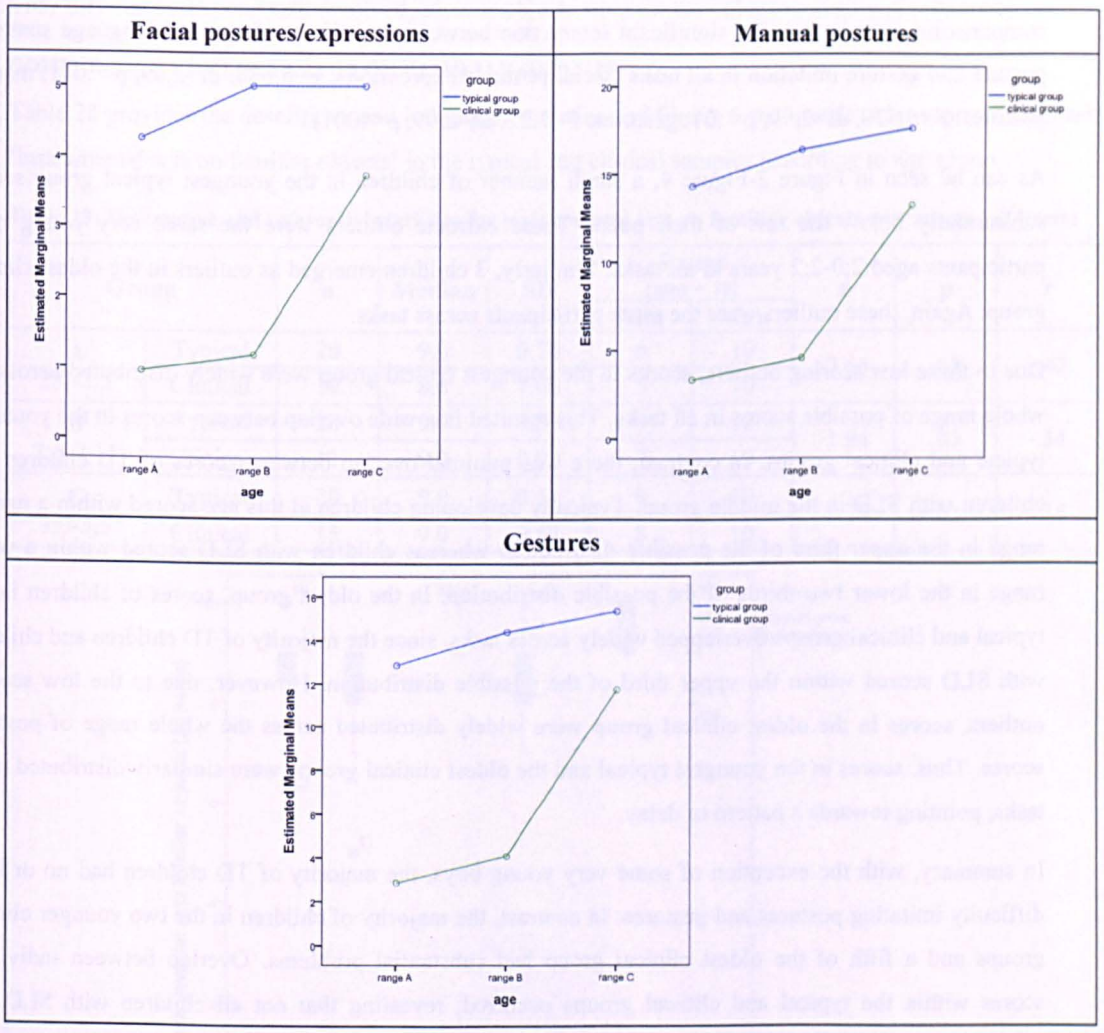

Figure 5: Estimated marginal means for facial posture/expression, manual posture and gesture scores for all groups

Significant differences were found between all typical and clinical groups on *all* posture and gesture tasks, except for the 3-year-old groups on the gesture task. The effect sizes for group differences were large for the two younger groups and medium for the oldest groups across tasks.

As can be seen in Figure 5, patterns of scores for the typical and clinical samples were similar across the three measures. All groups in the *typical* sample scored towards or at ceiling on all posture and gestures tasks. This shows that TD children across age ranges completed posture and gesture tasks with little difficulty. In contrast, children in the two younger groups in the *clinical* sample scored substantially lower on all posture and gesture tasks than children in the typical sample. This reveals that most 2-year-old children with SLD had severe difficulty with the imitation of postures and gestures. Interestingly, the majority of children in the oldest clinical group performed much better than children in the two younger

clinical groups. Since the two younger groups in the clinical sample performed significantly below the oldest group in the clinical sample, an interaction effect between the age and group factors was expected. Factorial ANOVAs were used to check this expectation, although strictly speaking assumptions were not met for this parametric analysis. Results were in line with descriptive statistics and non-parametric comparisons and confirmed a significant interaction between the effects of age and language status on posture and gesture imitation in all tasks (facial postures/expressions: $F=8.084$, $df=2,99$, $p< .001$; manual postures: $F=6.579$, $df=2,99$, $p< .01$; gestures: $F=7.22$, $df=2,99$, $p< .001$).

As can be seen in Figure 2-Figure 4, a small number of children in the youngest typical group scored substantially below the rest of their peers. These extreme outliers were the same very young male participants aged 2;0-2;2 years in all tasks. Similarly, 3 children emerged as outliers in the oldest clinical group. Again, these outliers were the same participants across tasks.

Due to these low scoring outliers, scores in the youngest typical group were widely distributed across the whole range of possible scores in all tasks. This resulted in a wide overlap between scores in the youngest typical and clinical groups. In contrast, there was minimal overlap between scores of TD children and children with SLD in the middle group. Typically developing children at this age scored within a narrow range in the upper third of the possible distribution whereas children with SLD scored within a wider range in the lower two thirds of the possible distribution. In the oldest group, scores of children in the typical and clinical groups overlapped widely across tasks, since the majority of TD children and children with SLD scored within the upper third of the possible distribution. However, due to the low scoring outliers, scores in the oldest clinical group were widely distributed across the whole range of possible scores. Thus, scores in the youngest typical and the oldest clinical groups were similarly distributed in all tasks, pointing towards a pattern of delay.

In summary, with the exception of some very young boys, the majority of TD children had no or little difficulty imitating postures and gestures. In contrast, the majority of children in the two younger clinical groups and a fifth of the oldest clinical group had substantial problems. Overlap between individual scores within the typical and clinical groups occurred, revealing that not all children with SLD had difficulty. Patterns of results for all posture and gesture tasks were similar. Thus, it had no impact on children's imitation performance whether target items conveyed nonverbal symbolic meaning or not. Results are in line with the expectation that some children with SLD would have difficulties to imitate nonverbal target acts that were categorised as intention-sensitive.

3.4.2 OSI measures: Common instrumental acts on objects

The second part of the imitation battery, actions on objects, included two tasks measuring the imitation of common instrumental acts on objects. The tasks were categorised as outcome-sensitive (OSI measures). They differed in that one task involved *familiar* objects whereas the other involved *unfamiliar* objects.

COMMON INSTRUMENTAL ACTS ON FAMILIAR OBJECTS

Table 28 provides the descriptive and inferential statistics and Figure 6 the boxplots for scores of the task 'instrumental acts on familiar objects' in the typical and clinical samples according to age group.

Table 28: Descriptive and inferential statistics for instrumental acts on familiar objects raw scores (all items)

Group		n	Median	SD	Range (max = 10)		z	p	r
					Min	Max			
A 2;0-2;5	Typical	20	9.0	0.76	6	10	-2.65	.01	-.42
	Clinical	19	8.0	1.06	5	10			
B 2;6-2;11	Typical	20	9.0	0.36	9	10	-1.94	.05	-.34
	Clinical	11	9.0	0.92	7	10			
C 3;0-3;5	Typical	20	9.0	0.51	9	10	-2.29	.05	-.38
	Clinical	15	9.0	0.53	8	10			

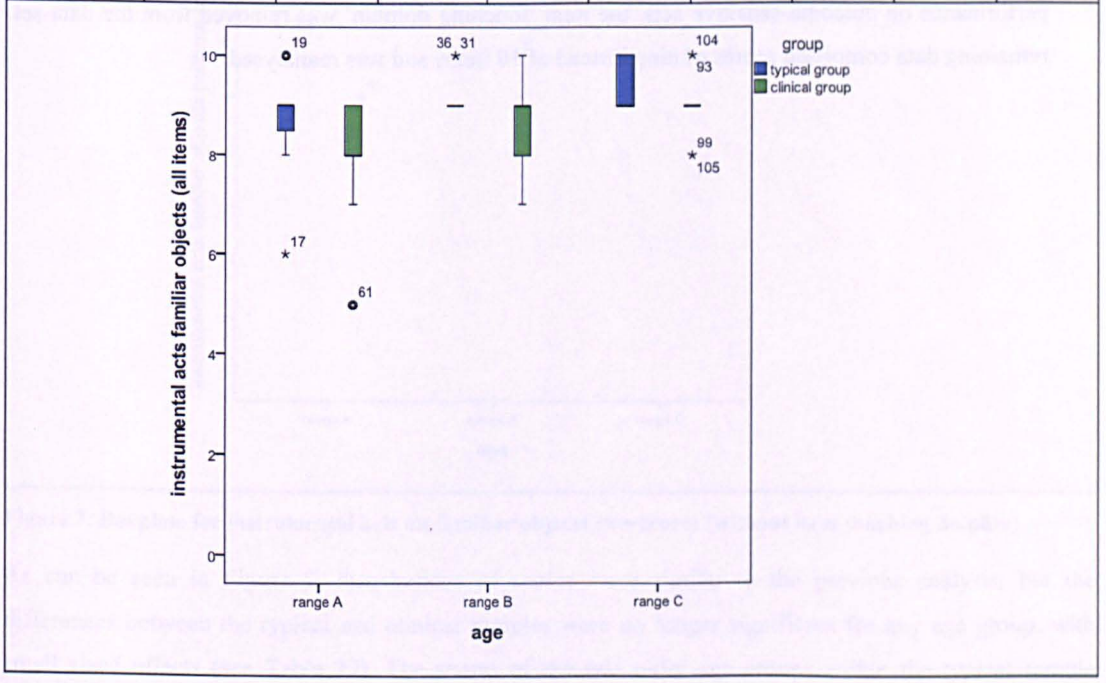

Figure 6: Boxplots for instrumental acts on familiar objects raw scores according to age and group (all items)

As can be seen in Figure 6, the majority of children at all ages in the typical and clinical samples scored towards ceiling. Scores in the typical and clinical samples were similar and overlapped widely. No child in any group refused to comply with the task. However, the differences between the typical and clinical samples remained significant at all ages, with medium sized effects (Table 28).

This task comprised 10 simple, highly familiar target acts that were expected to be carried out effortlessly by all participants (see section 2.4.3). Contrary to this expectation, results revealed significant differences between the typical and clinical samples at all ages. Since it was observed during the administration of the imitation battery that a number of children in the SLD group had particular difficulties with the item 'touching dolphin' but not with any other items of this task, it was of interest whether group differences were due to this specific item. Therefore, performance of children in the typical and clinical samples was compared separately item by item. Analyses revealed significant differences between typical and clinical groups at all ages for the item 'touching dolphin' (group A: $z = -2.46$, $p < .05$, $r = -.40$; group B: $z = -2.84$, $p < .01$, $r = -.51$; group C: $z = -2.48$, $p < .05$, $r = -.42$). The differences between typical and clinical groups for all other items were not significant. Qualitative analysis of children's imitation errors revealed that, in contrast to the other test items, the act 'touching dolphin' was not limited to one action with one singular outcome (see section 3.5.4). Instead, the soft toy could be associated with different actions (e.g. swimming). In addition, it was realised that the manner of movement in which the item was presented (stroking a dolphin versus tapping a dolphin, see section 2.4.3) could have connotations of emotional expression. Consequently, the item 'touching dolphin' cannot be categorised as 'entirely' outcome-sensitive. Since the task instrumental acts on familiar objects was designed to investigate children's performance on outcome-sensitive acts, the item 'touching dolphin' was removed from the data-set. The remaining data comprised scores of nine instead of 10 items and was reanalysed.

Table 29 provides the descriptive and inferential statistics and Figure 7 the boxplots for the reanalysed data of the task 'instrumental acts on familiar objects' (without the item 'touching dolphin') in the typical and clinical samples according to age group.

Table 29: Descriptive and inferential statistics for instrumental acts on familiar objects raw scores (without item touching dolphin)

Group		n	Median	SD	Range (max = 9)		z	p	r
					Min	Max			
A 2;0-2;5	Typical	20	8.0	0.51	6	9	-1.73	ns	-.27
	Clinical	19	8.0	0.83	5	9			
B 2;6-2;11	Typical	20	8.0	0.36	8	9	-0.30	ns	-.05
	Clinical	11	8.0	0.77	6	9			
C 3;0-3;5	Typical	20	9.0	0.30	8	9	-0.30	ns	-.05
	Clinical	15	9.0	0.35	8	9			

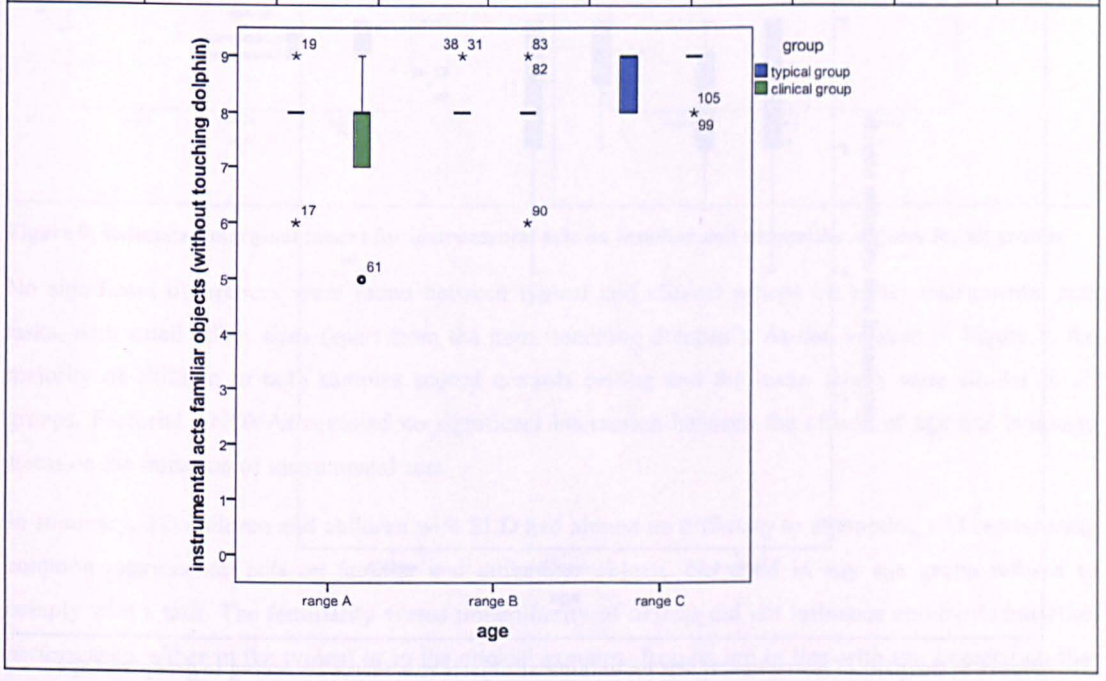

Figure 7: Boxplots for instrumental acts on familiar objects raw scores (without item touching dolphin)

As can be seen in Figure 7, distributions of scores were similar to the previous analysis, but the differences between the typical and clinical samples were no longer significant for any age group, with small sized effects (see Table 29). The scores of the two older age groups within the typical sample differed from each other ($z = -4.37$, $p < .001$), as did the scores of the two older age groups within the clinical sample ($z = -3.44$, $p < .001$). No significant age difference was found between the two younger age groups in the typical or clinical samples.

COMMON INSTRUMENTAL ACTS ON UNFAMILIAR OBJECTS

Table 30 provides the descriptive and inferential statistics and Figure 8 the boxplots for scores of the task 'instrumental acts on unfamiliar objects' in the typical and clinical samples according to age group.

Table 30: Descriptive and inferential statistics for instrumental acts on unfamiliar objects raw scores

Group		n	Median	SD	Range (max = 8)		z	p	r
					Min	Max			
A 2;0-2;5	typical	20	7.0	1.30	4	8	-1.29	ns	-.20
	clinical	19	6.0	1.11	5	8			
B 2;6-2;11	typical	20	7.5	0.75	6	8	-1.37	ns	-.24
	clinical	11	7.0	1.27	4	8			
C 3;0-3;5	typical	20	8.0	0.41	7	8	-0.64	ns	-.20
	clinical	15	8.0	1.12	4	8			

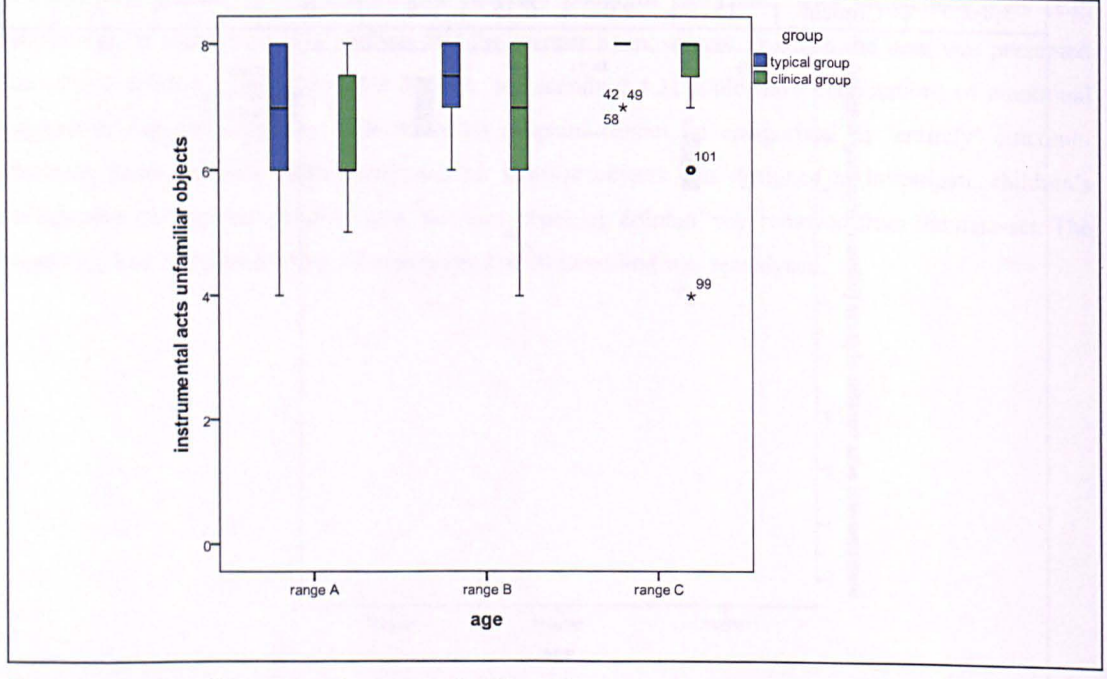

Figure 8: Boxplots of instrumental acts on unfamiliar objects raw scores according to group and age

As can be seen in Figure 8, the majority of children at all ages in the typical and clinical samples scored towards or at ceiling. Scores of children in the typical and clinical samples overlapped widely and showed similar patterns of distributions. No child in any group refused to comply with the task. The differences between median scores of typical and clinical groups at all ages were not significant, representing small sized effects (see Table 30). The scores of the two older age groups within the typical sample differed from each other ($z = -2.13$, $p<.05$). No other significant age differences were found.

SUMMARY INSTRUMENTAL ACTS

Figure 9 provides line graphs showing estimated marginal means for scores on the task instrumental acts on familiar objects (without the item 'touching dolphin') and on the task instrumental acts on unfamiliar objects in the typical and clinical samples according to age group.

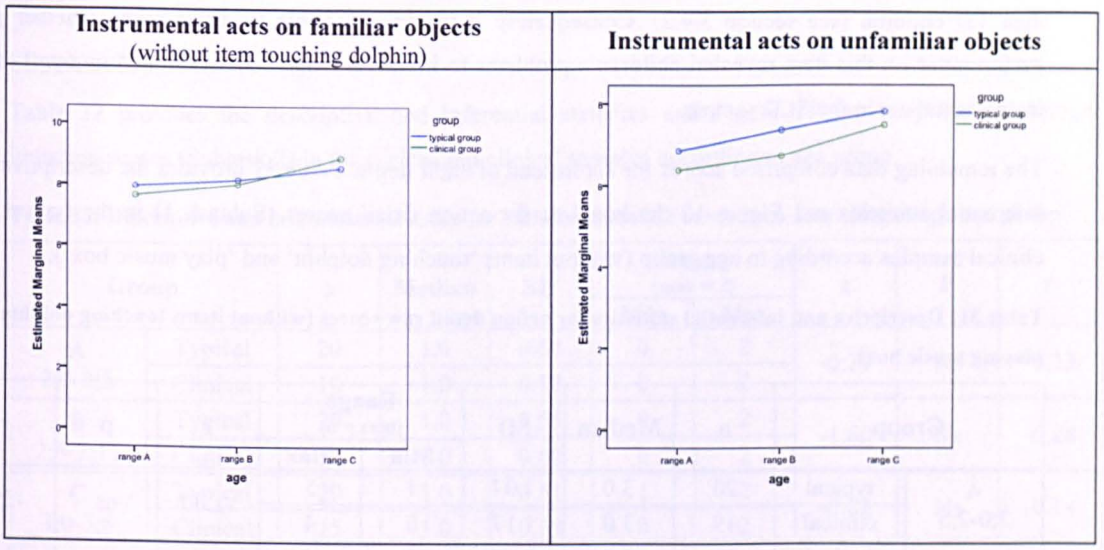

Figure 9: Estimated marginal means for instrumental acts on familiar and unfamiliar objects for all groups

No significant differences were found between typical and clinical groups on either instrumental acts tasks, with small effect sizes (apart from the item 'touching dolphin'). As can be seen in Figure 9, the majority of children in both samples scored towards ceiling and the mean scores were similar in all groups. Factorial ANOVAs revealed no significant interaction between the effects of age and language status on the imitation of instrumental acts.

In summary, TD children and children with SLD had almost no difficulty to attempting and reproducing common instrumental acts on familiar and unfamiliar objects. No child in any age group refused to comply with a task. The familiarity versus unfamiliarity of objects did not influence children's imitation performance, either in the typical or in the clinical samples. Results are in line with the expectation that children with SLD would have no difficulty to imitating nonverbal target acts that were categorised as outcome-sensitive.

3.4.3 Subtasks 1 and 2

Instrumental acts on familiar objects were in addition designed to measure the imitation of action details (Subtask 1) and the ability to adapt performance according to different imitative contexts (Subtask 2).

SUBTASK 1: ACTION DETAILS

Eight items were designed to measure unnecessary action details of instrumental acts (see section 2.4.3). However, the items 'playing music box' and 'touching dolphin' were removed from the data-set for the following reasons:

Item playing music box: Despite careful construction and piloting, many children in the typical and clinical samples had difficulty turning the handle of the music box effortlessly enough to realise the style of movement (i.e. turning handle gently or forcefully).

Item touching dolphin: On average, children with SLD had more difficulty with the act 'touching dolphin' than TD children (see section 3.4.2). Consequently it was not possible to differentiate whether poor performance on this item revealed children's problems to imitate the *outcome* or the *action detail* of the instrumental act in the SLD sample.

The remaining data comprised scores for six instead of eight items. Table 31 provides the descriptive and inferential statistics and Figure 10 the boxplots for action detail scores (Subtask 1) in the typical and clinical samples according to age group (without items 'touching dolphin' and 'play music box').

Table 31: Descriptive and inferential statistics for action detail raw scores (without items touching dolphin and playing music box)

Group		n	Median	SD	Range (max = 6)		z	p	r
					Min	Max			
A 2;0-2;5	typical	20	3.0	1.07	1	5	-1.60	ns	-.25
	clinical	19	3.0	1.17	0	4			
B 2;6-2;11	typical	20	3.0	0.92	3	6	-0.52	ns	-.09
	clinical	11	4.0	1.48	1	6			
C 3;0-3;5	typical	20	5.0	0.79	3	6	-0.87	ns	-.14
	clinical	15	5.0	0.86	4	6			

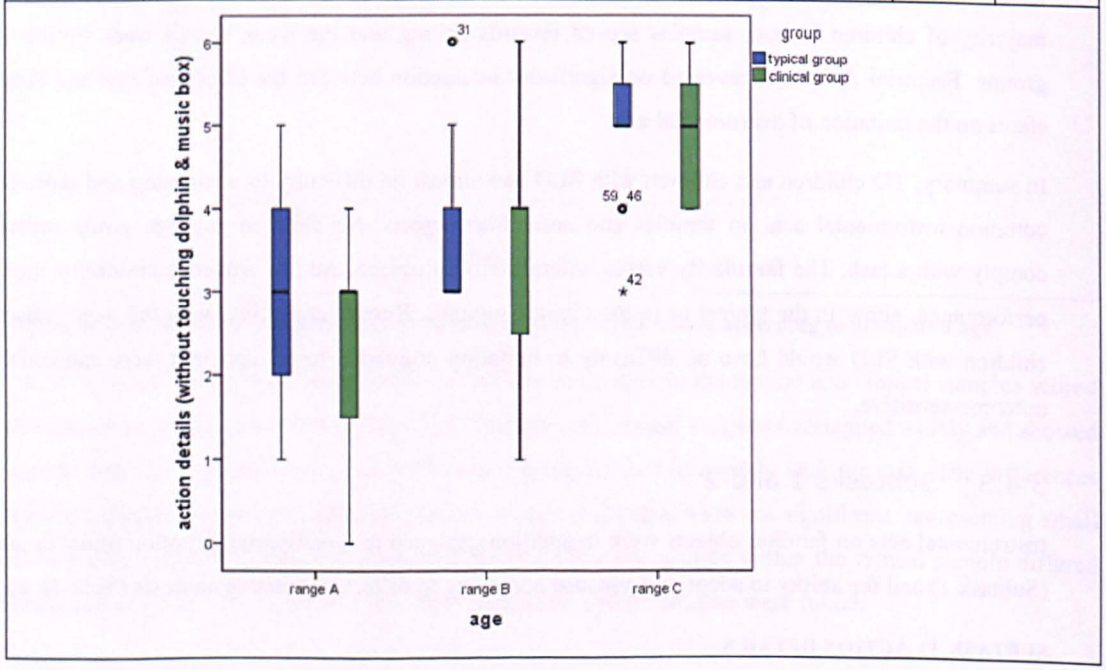

Figure 10: Boxplots of action detail raw scores (without items touching dolphin and play music box)

As can be seen in Table 31, the differences between median scores of typical and clinical groups at all ages were not significant, representing small sized effects. Figure 10 shows that scores in the typical and clinical samples overlapped widely and had similar distributions. The majority of children in the two

younger groups in the clinical and typical samples scored within the middle third of the possible range of scores, whereas the majority of children in the oldest group scored within the upper third of the possible range of scores. Accordingly, the scores of the two older age groups in the typical ($z = -3.84$, $p < .001$) and clinical ($z = -3.02$, $p < .01$) samples differed from each other but no other significant age differences were found.

SUBTASK 2: RATIONAL IMITATION

Table 32 provides the descriptive and inferential statistics and Figure 11 the boxplots for rational imitation scores (Subtask 2) in the typical and clinical samples according to age group.

Table 32: Descriptive and inferential statistics for rational imitation raw scores according to age and group

Group		n	Median	SD	Range (max = 2)		z	P	r
					Min	Max			
A 2;0-2;5	Typical	20	1.0	0.64	0	2	-0.79	Ns	-0.12
	Clinical	19	1.0	0.57	0	2			
B 2;6-2;11	Typical	20	1.0	0.55	0	2	-1.60	Ns	-0.28
	Clinical	11	1.0	0.60	0	2			
C 3;0-3;5	Typical	20	1.0	0.51	1	2	-0.86	Ns	-0.14
	Clinical	15	1.0	0.59	0	2			

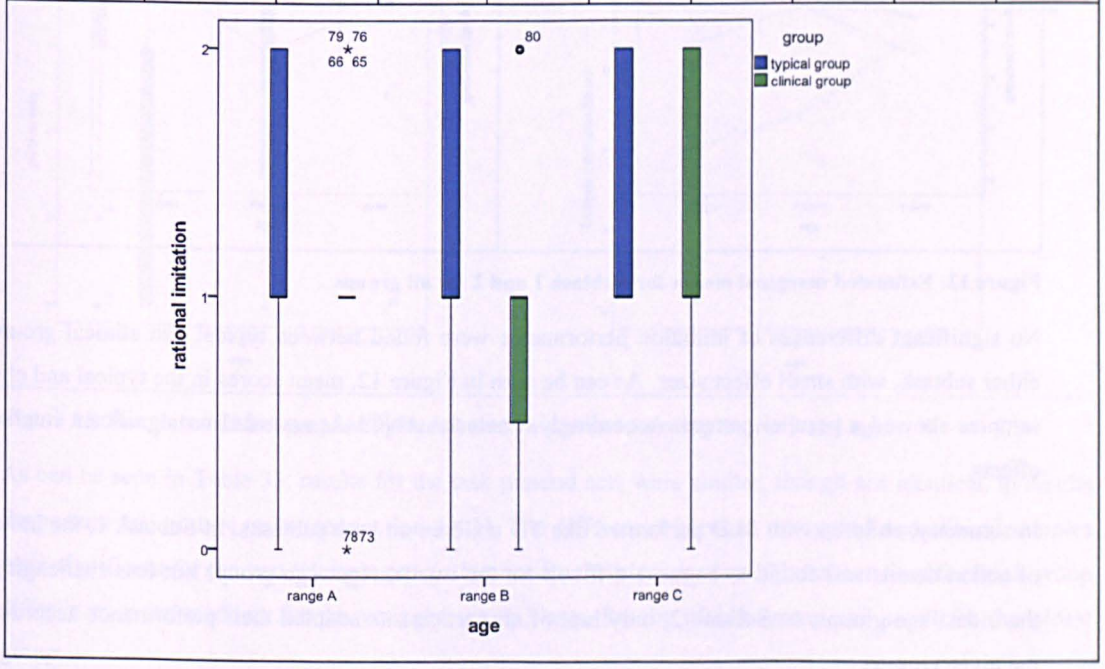

Figure 11: Boxplots of rational imitation raw scores according to age and group

As can be seen in Figure 11, the median score for all groups in the typical and clinical samples was 1. The differences between median scores of typical and clinical groups at all ages were not significant, representing small sized effects (see Table 32).

Recall that in the *first condition* of moving the mouse into the house, children were expected to use the door instead of the chimney, since the door was closed while the instructor performed the act (see section 2.4.3). However, only 51.6% of the TD children and 40% of the children with SLD adapted their

performance and chose the door instead of the chimney. All other children imitated exactly what the demonstrator performed, i.e. chose the chimney. Thus, broadly half of the participants adapted their performance but as many did not.

In the *second condition*, children were expected to use the chimney, since the door was already open implying that the demonstrator had deliberately selected the unusual chimney-route to take the mouse into the house. And indeed, the majority of TD children (81%) and children with SLD (68.8%) chose the chimney to enter the house.

SUMMARY SUBTASKS 1 AND 2

Figure 12 provides line graphs showing estimated marginal means for scores of Subtask 1 and 2 in the typical and clinical samples according to age group.

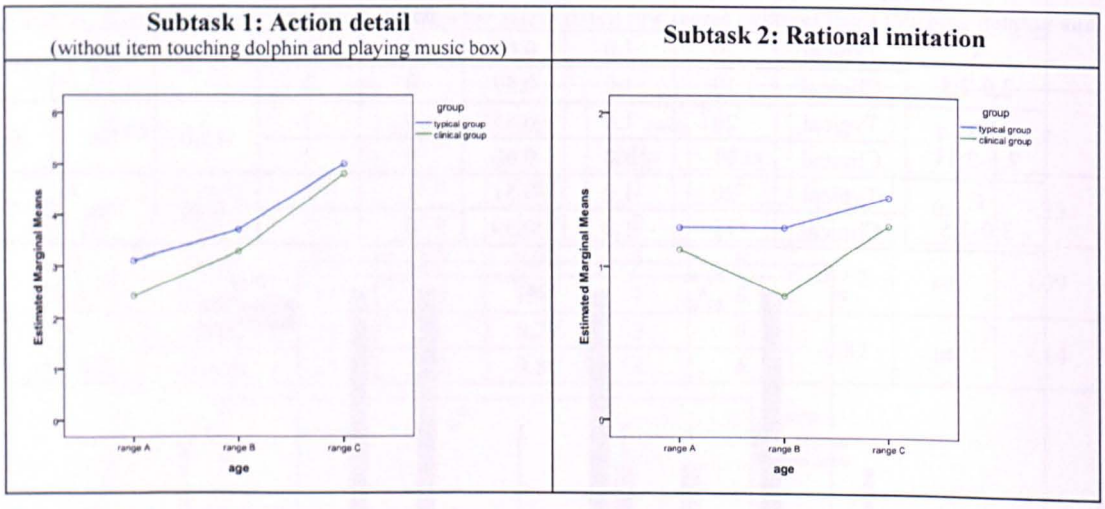

Figure 12: Estimated marginal means for Subtask 1 and 2 for all groups

No significant differences of imitation performance were found between typical and clinical groups on either subtask, with small effect sizes. As can be seen in Figure 12, mean scores in the typical and clinical samples showed a parallel pattern. Accordingly, Factorial ANOVAs revealed no significant interaction effects.

In summary, children with SLD performed like TD children on both subtasks. In Subtask 1, the imitation of action details was found to be more difficult for the two younger age groups but less challenging for the oldest age groups. In Subtask 2, only half of all participants adapted their performance according to the given context.

3.4.4 Hybrid measure: Pretend acts on substitute objects

As well as instrumental acts on familiar and unfamiliar objects, the second part of the imitation battery included the task pretend acts on substitute objects. The imitation of pretend acts was categorised as hybrid measure, since it involves real objects without resulting in observable functional outcomes.

Table 33 provides the descriptive and inferential statistics and Figure 13 the boxplots and line graphs for pretend act scores in the typical and clinical samples according to age group.

Table 33: Descriptive and inferential statistics for pretend act raw scores according to group and age

Group		n	Median	SD	Range (max = 8)		z	p	r
					Min	Max			
A 2;0-2;5	Typical	20	7.5	2.28	0	8	-2.91	.010	-.46
	Clinical	19	4.0	3.07	0	8			
B 2;6-2;11	Typical	20	8.0	0.60	6	8	-3.88	.001	-.69
	Clinical	11	6.0	2.48	0	7			
C 3;0-3;5	Typical	20	7.0	0.66	6	8	-0.51	ns	-.08
	Clinical	15	7.0	2.01	0	8			

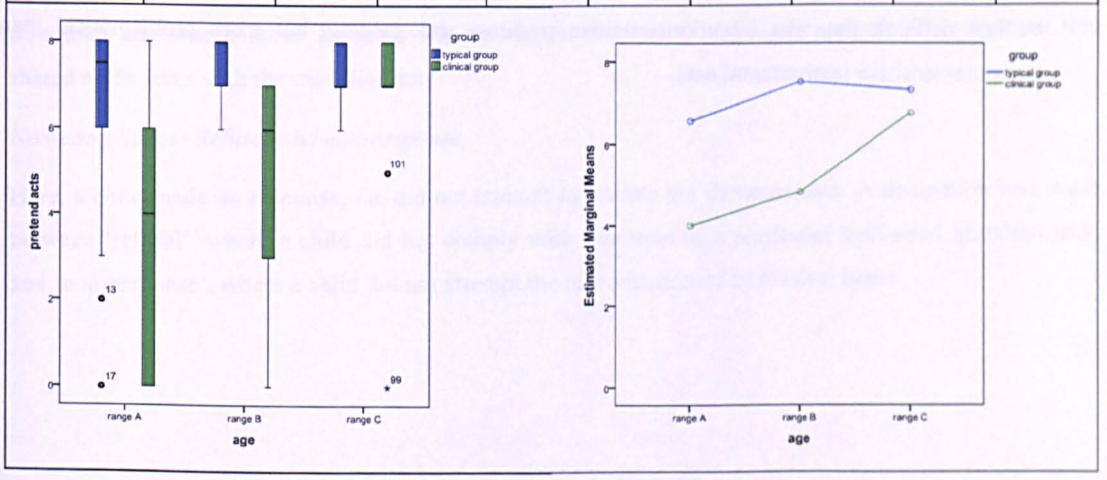

Figure 13: Boxplots and line graphs of pretend act raw scores according to group and age

As can be seen in Table 33, results for the task pretend acts were similar, though not identical, to results for posture and gesture tasks (see section 3.4.1). The differences between the typical and clinical samples were significant for the two younger groups but not for the oldest groups. The effect sizes for these group differences were medium for the youngest group, large for the middle group and small for the oldest group.

As can be seen in Figure 13, the majority of children in all typical groups scored towards ceiling, except 2 low scoring children who emerged as outliers in the youngest typical group. These outliers were the same young male participants who emerged as outliers in the posture and gesture tasks. The median scores of the two younger clinical groups were lower than in the typical groups for the pretend acts task but higher than they were in the posture and gesture tasks. A smaller percentage of children in the two younger clinical groups refused to comply with the pretend acts task than with the posture and gesture tasks (31.0 % and 9.1 % respectively).

The majority of children in the oldest clinical age group performed better than the middle clinical age group, and this difference was significant ($z = -2.72$, $p < .01$). No other significant age differences were found. A Factorial ANOVA was used to check for an interaction effect but revealed no significant interaction between age and language status on the imitation of pretend acts.

Scores for the typical and clinical samples overlapped in all age groups. As in the posture and gesture tasks, scores in the youngest typical and the oldest clinical groups were similarly distributed, pointing towards a pattern of delay.

In summary, the majority of TD children had no or little difficulty imitating pretend acts on substitute objects. In contrast, some children with SLD in the two younger groups had problems with this task. However, young children with SLD were more likely to comply with the pretend act than the posture and gesture tasks. This resulted in higher median scores in the two younger clinical groups, and a wider overlap between scores of TD children and children with SLD at all ages.

The imitation of pretend acts had been categorised as hybrid measure. Results are in line with this categorisation, since the imitation of pretend acts on counterfunctional substitute objects was revealed to be less difficult than the intention-sensitive postures and gestures but more problematical than the outcome-sensitive instrumental acts.

3.5 Nonverbal imitation errors

Patterns of nonverbal imitation errors in the typical and clinical samples were compared to determine

- whether the types of errors occurring in the clinical sample resemble those of the typical sample or whether they are qualitatively different
- whether the rates of different errors occurring in the oldest clinical group resemble those of the youngest typical group
- whether children who produce non-responses show a pattern of *general* refusal to comply with the imitation battery or a pattern of *specific* refusal to comply with certain tasks or even items of the imitation battery.

A distinction was made between two types of responses that were scored as errors:

Incorrect response

A response was scored as incorrect if a child tried to imitate the demonstrator but failed to accurately reproduce the target act. Incorrect responses were further distinguished as either *partial errors* (i.e. responses that shared some features with the demonstration) or *unrelated errors* (i.e. responses that shared no features with the modelled act).

Non-compliance: Refusal and non-response

Here, a child made no response, i.e. did not attempt to imitate the demonstrator. A distinction was made between 'refusal', where a child did not comply with *any item* of a particular nonverbal imitation task, and 'non-response', where a child did not attempt the reproduction of *individual* items.

3.5.1 Refusal

Table 34 presents the percentage of participants in the typical and clinical samples who refused all items of a task, according to task and age group.

Table 34: Percentage of participants in the typical and clinical samples who refused all items of a task

Task according to age	Typical sample		Clinical sample	
	n	%	N	%
Facial postures/expressions				
A (2;0-2;5)	20	10	19	68.4
B (2;6-2;11)	20	0	11	63.6
C (3;0-3;5)	20	0	15	20
Manual postures				
A (2;0-2;5)	20	10	19	52.6
B (2;6-2;11)	20	0	11	45.5
C (3;0-3;5)	20	0	15	20
Gestures				
A (2;0-2;5)	20	10	19	63.2
B (2;6-2;11)	20	0	11	36.4
C (3;0-3;5)	20	0	15	20
Pretend acts				
A (2;0-2;5)	20	10	19	31.0
B (2;6-2;11)	20	0	11	9.1
C (3;0-3;5)	20	0	15	6.6
Instrumental acts on familiar objects				
A (2;0-2;5)	20	0	19	0
B (2;6-2;11)	20	0	11	0
C (3;0-3;5)	20	0	15	0
Instrumental acts on unfamiliar objects				
A (2;0-2;5)	20	0	19	0
B (2;6-2;11)	20	0	11	0
C (3;0-3;5)	20	0	15	0

As can be seen in Table 34, in the **typical sample**, the majority of children complied with all nonverbal imitation tasks, with just 10% of participants in the youngest group refusing the facial postures/expressions, manual postures, gestures and pretend acts tasks. The 'refusers' were the same participants in all tasks, i.e. the 2 youngest male participants (2;0 and 2;2 years). No participant in the typical sample refused all items in the instrumental act tasks.

In the **clinical sample**, a large percentage of participants in the youngest group (52.6%-68.4) refused all items of the posture and gesture tasks. In the middle group, a smaller percentage refused all items of these tasks, with the highest refusal rate occurring for the facial postures/expressions task (63.6%) and the lowest for the gesture task (36.4%). Only one fifth of participants in the oldest group (3 children) refused all items of the posture and gesture tasks. Thus, refusal rates were higher for the 2-year-old than for the 3-year-old clinical groups for the posture and gesture tasks. The percentage of participants in the clinical sample who refused to comply with the pretend acts task (6.6-31.0%) was substantially lower (see Table 34), and as in the typical sample, no participant in the clinical sample refused the instrumental acts tasks.

In conclusion, refusal to comply with all items of a nonverbal imitation task occurred in the typical *and* clinical samples, and furthermore for the same tasks in both samples. No child refused all tasks: refusal occurred in the ISI and hybrid measures (postures, gestures, pretend acts), but not in the OSI measures (instrumental acts). Within the clinical sample, refusal-rates were higher for the ISI than for the hybrid tasks. Thus, children in the clinical sample showed a pattern of *selective* refusal affecting those nonverbal imitation tasks that were expected to be difficult for some children with SLD, rather than *general* non-compliance affecting the whole imitation battery. This pattern is in line with the assumption that selective refusal is evidence of difficulty rather than uncooperativeness. In terms of *age*, refusal occurred *at all ages* in the clinical sample, but only in the *youngest group* in the typical sample. Refusal rates in the clinical sample reduced with age and refusal rates of the oldest clinical group were similar to those in the youngest typical group. The pattern of refusal in the clinical sample appears to reflect delay rather than deviance, since refusals occurred in the *same* nonverbal imitation tasks in the TD and SLD samples, and refusal rates of the oldest clinical group roughly resemble those of the youngest clinical group.

3.5.2 Levels of incorrect responses, refusals and non-responses

Table 35 provides the percentage of individual items categorised as correct, incorrect, refusal and non-response in the typical and clinical samples, according to task and age group. The first row states the total number of items by task and group, i.e. the number of items in each task multiplied by the number of children in each age group. Since children were only scored for 'attempt to imitate' in the facial postures/expressions tasks, the task was not included in this table.

Table 35: Percentage of items per task in the typical and clinical samples categorised as correct, incorrect, refusal and non-response, according to task and age group (A=2;0-2;5; B=2;6-2;11; C=3;0-3;5 years)

	Typical			Clinical		
Age group	**A**	**B**	**C**	**A**	**B**	**C**
Manual Postures						
Max. number of items (=100%)	200	200	200	190	110	150
Correct (%)	54.5	63.5	77.0	8.9	9.1	53.3
Incorrect (%)	35.0	36.5	23.0	17.4	21.8	26.7
Refusal (%)	10.0	0.0	0.0	52.6	45.5	20.0
Non-response (%)	0.0	0.0	0.0	21.1	23.6	0.0
Gestures						
Max. number of items (=100%)	160	160	160	152	88	120
Correct (%)	71.9	80.0	91.3	11.8	15.9	68.3
Incorrect (%)	18.1	20.0	8.8	13.2	20.5	11.7
Refusal (%)	10.0	0.0	0.0	63.2	36.4	20.0
Non-response (%)	0.0	0.0	0.0	11.8	27.0	0.0
Pretend acts						
Max. number of items (=100%)	80	80	80	76	44	60
Correct (%)	73.8	87.5	83.8	35.5	38.6	76.7
Incorrect (%)	16.3	12.5	16.3	30.3	43.2	16.7
Refusal (%)	10.0	0.0	0.0	31.0	9.1	6.6
Non-response (%)	0.0	0.0	0.0	3.2	9.1	0.0
Instrumental acts on unfamiliar objects						
Max. number of items (=100%)	80	80	80	76	44	60
Correct (%)	85.0	91.3	95.0	80.3	81.8	90.0
Incorrect (%)	13.8	8.8	5.0	14.5	15.9	6.7
Refusal (%)	0.0	0.0	0.0	0.0	0.0	0.0
Non-response (%)	1.3	0.0	0.0	5.3	2.3	3.3
Instrumental acts on familiar objects (without item 'touching dolphin')						
Max. number of items (=100%)	180	180	180	171	99	135
Correct (%)	89.5	91.5	99.0	86.8	90.0	98.0
Incorrect (%)	0.0	0.0	0.0	0.0	0.0	0.0
Refusal (%)	0.0	0.0	0.0	0.0	0.0	0.0
Non-response (%)	10.5	8.5	1.0	13.2	10.0	2.0

As can be seen in Table 35 in the **typical sample**, refusals and non-responses were rare: almost all TD children attempted to imitate *all* items of all tasks. However, a tenth of items in the youngest group were categorised as refusals in the posture, gesture and pretend acts tasks, and non-responses for a small number of individual items occasionally occurred in the instrumental acts tasks. The majority of errors in the TD sample were incorrect responses. These occurred *at all ages* in all nonverbal imitation tasks, except in instrumental acts on familiar objects. Roughly a third of manual posture items, a fifth of gesture items and a tenth of instrumental acts on unfamiliar objects items elicited incorrect responses in the two *younger* groups, with a lower level of incorrect responses emerging in the *oldest* group. In the pretend acts task, a similar level of incorrect responses occurred across age groups (12.5-16.3%).

In the **clinical sample**, the majority of *manual posture and gesture* errors in the two *younger* groups were non-compliance with the whole task (refusal) or individual items (non-response), with roughly two-thirds to three-quarters of posture and gesture items eliciting refusal or non-response. In the *oldest* group, non-compliance rates in the ISI measures were clearly lower, with only one fifth of items emerging as refusal and no items emerging as non-responses. In all age groups, between a tenth and a quarter of posture and gesture items produced incorrect responses (see Table 35). Thus, in the two younger groups, the level of non-compliance was *higher* than the level of incorrect responses in the ISI measures. Turning to the pretend acts task, *fewer* items were categorised as refusal or non-response and *more* items were categorised as incorrect: one third of pretend acts elicited *non-compliance* in the youngest group, reducing to under a tenth in the oldest group, and one third elicited *incorrect responses* in the youngest group, increasing in the middle and decreasing in the oldest age group. Thus, the level of non-compliance was either similar or *lower* than the level of incorrect responses in this hybrid measure. In the instrumental acts on unfamiliar objects task, roughly one tenth of responses were incorrect in the youngest group, and this reduced with age, whereas no incorrect responses occurred in the instrumental acts on familiar objects task. Thus, no refusal and only occasional non-responses occurred in the OSI measures. Overall then, different patterns of error in terms of levels of incorrect responses, non-responses and refusal emerged for tasks categorised as ISI, hybrid and OSI within the clinical sample.

A comparison of error patterns between samples reveals *how* performance of the TD and SLD samples differed regarding different *types* of nonverbal imitation:

- In the **ISI tasks**, the percentage of incorrect responses in the clinical sample was similar to or lower than in the typical sample, whereas a *higher* percentage of non-compliance occurred in the clinical sample at all ages. Hence, the significantly poorer performance of the clinical sample on these tasks was entirely due to higher levels of non-compliance. Importantly, this applies *across age groups*, though lower non-response rates in the oldest group resulted in a lower significance level (manual postures) or in a non-significant difference (gestures).
- A different error pattern emerged for the **hybrid** task, since levels of incorrect responses as well as non-compliance were *higher* in the younger clinical groups, with incorrect responses approximately twice or three times as high in the younger clinical compared with the younger typical groups. Accordingly, the differences between samples stemmed from higher percentages of *all* error types in

the two younger clinical groups. Percentages of error types were similar in the oldest typical and clinical group, manifesting in a non-significant difference.

- In the **OSI tasks,** levels of incorrect responses, refusal and non-responses were very similar in the typical and clinical samples, manifesting in non-significant differences in all comparisons.

Comparing pattern of errors across samples, it is striking that *types* and *rates* of errors in the oldest clinical group closely resemble those in the youngest typical group across tasks. This suggests a delayed rather than deviant pattern of response on these tasks.

A further notable aspect is that non-responses in the two younger clinical groups were *selective* occurring, most frequently in ISI measures that were expected to be most difficult for some children with SLD. Like the pattern of selective refusal (see section 3.5.1), this pattern of selective non-response is in line with the assumption that non-compliance is evidence of difficulty rather than uncooperativeness. However, in the oldest clinical group, very few non-responses occurred in any nonverbal imitation task, in line with the observation that levels of non-compliance were generally very low at this age.

3.5.3 Types of incorrect responses

This section analyses which specific types of incorrect responses occurred in the typical and clinical samples, to determine whether the *same* incorrect responses occurred in the TD and SLD samples or whether incorrect responses were *qualitatively different.* As specified above, the term 'incorrect response' comprises *partial* as well as *unrelated* errors. A detailed list and description of *individual* partial errors according to each nonverbal imitation task can be found in the appendix (see Appendix D).

In general, children's incorrect responses fitted the error categories described in the methodology section (see section 2.4), but two types of response had not been anticipated: aided and substantially delayed responses. In an *aided response*, a child insisted on carrying out an action on a parent, together with the instructor or via a soft toy instead of acting it out by her/himself (e.g. pull instructors ear, pretend to feed daddy with a spoon, let the hippo produce a posture). Aided responses occurred in both typical and clinical samples, but only occasionally (typical sample: three items; clinical sample: six items). In a *substantially delayed response*, a child attempted to reproduce an act, but only after a delay of more than five seconds. Substantially delayed responses occurred very occasionally, and only in the clinical sample (four items). Due to the small number of aided and substantially delayed responses, these types of errors were not considered further.

3.5.4 Partial errors

The majority of incorrect responses in the TD and SLD samples were partial errors. Children in the typical and clinical samples produced a very similar range of errors in all nonverbal imitation tasks, with almost all types of partial errors in the SLD sample resembling those of the TD sample (see Appendix D).

More important was the difference in responses to pretend acts on substitute objects. Scoring criteria for **pretend acts** differentiated between *conventional* and *inaccurate* partial errors. Errors were defined as conventional if the child used a substitute object in its conventional way (e.g. 'eat with spoon' for 'pretend to brush hair with spoon'), and as inaccurate if the child showed inaccuracies in the use of a substitute object (e.g. 'brush in front of the face' for 'pretend to brush hair with spoon'). The same types of partial errors, whether conventional or inaccurate, occurred in the typical and clinical samples. However, the proportion of conventional to inaccurate errors was reversed in the TD and SLD samples: in the typical sample one-third of the 36 partial errors were categorised as conventional (33.3%) and two-thirds as inaccurate (66.6%), whereas in the clinical sample approximately two-thirds of the 52 partial errors were categorised as conventional (65.4%) and one-third as inaccurate (34.6%). Thus, children in the SLD sample were twice as likely to use an object in its conventional or instrumental way, instead of imitating the counterfunctional action.

Furthermore, children in the clinical sample did not respond as expected on the item **'touching dolphin'** (see section 3.4.2). Instead of replicating the demonstrated outcome of the instrumental act on a familiar object (touching dolphin), they performed a range of different actions that they associated with the soft toy (let dolphin swim, show dolphin the room, throw dolphin in the air, throw dolphin away). Similarly, children did not imitate the target action details (tapping versus stroking), but instead kneaded, smacked or squeezed the dolphin. In contrast, children in the typical sample performed only the expected outcome and action details. Thus, children in the TD and SLD samples responded differently to the item 'touching dolphin'.

3.5.5 Unrelated errors

Unrelated errors were rare and occurred only in the clinical sample for certain nonverbal imitation tasks (manual posture and gesture task). Two types of unrelated errors were observed: a preservation of the previous practice item instead of a reproduction of the first test item, and body movements that did not fulfil the criteria for partial errors specified for postures and gestures. Two different body movements occurred: clap hands for the item 'pat elbow' and move hand(s)/arm(s) for the items 'arm flexes at elbow', 'hand pulling one ear', 'waving', and 'pretend to sleep', 'pretend to throw ball'. These could be viewed as very extreme errors, rather than unrelated, but they were classifies as unrelated because they did not fulfil criteria for partial errors. Overall, only 6.3% of the 223 incorrect responses that occurred for all main nonverbal imitation tasks in the clinical sample were categorised as unrelated.

3.6 Relations between composites of ISI and language in the clinical sample

It was hypothesised that some children with SLD would have difficulty with nonverbal imitation tasks categorised as intention-sensitive, since these measures were argued to be indicative of sociocognitive capacities and some children with SLD are expected to have difficulty with social cognition. In contrast, it was hypothesised that nonverbal imitation tasks identified as outcome-sensitive would be no more challenging for children with SLD than for TD children, since these measures are relatively independent of sociocognitive capacities. In line with these hypotheses, the clinical sample performed significantly below their TD peers on the three intention-sensitive posture and gesture tasks, whereas performance of clinical and typical samples did not differ on the outcome-sensitive instrumental tasks. The pretend acts task was characterised as a hybrid measure. Results were in line with this categorisation, since the task significantly differentiated performance of typical and clinical samples, but not as consistently across age groups and with smaller effect sizes compared with the posture and gesture tasks (see section 3.4). It was further hypothesised that deficits in nonverbal imitation, especially deficits in ISI, would be related to language deficits, especially deficits in receptive language. The next step was therefore to investigate whether performance on the three intention-sensitive posture and gesture tasks related to performance on expressive and receptive language in the clinical sample. In order to investigate correlations between ISI and language skills, composites of ISI scores (see section 3.6.1) and of receptive and expressive language scores (see section 3.6.3) in the clinical sample were constructed.

3.6.1 ISI composite in the clinical sample

Based on theoretical categorisation of ISI tasks and results on these reported above, an ISI composite was derived from the three posture and gesture tasks. The creation of this composite was validated by correlational analyses. Since differences were found between age groups within the clinical sample (see section 3.4.1), the correlational analyses were conducted separately for each age group. Spearman's rho correlations were used because assumptions of normality were violated for most data sets.

Table 36: Relations between posture and gesture raw scores in the clinical sample according to age

		Facial postures/expressions	Manual postures	Gestures
A 2;0-2;5	Facial postures/expressions	---	.659**	.725***
	Manual postures	---	---	.790***
	Gestures	---	---	---
B 2;6-2;11	Facial postures/expressions	---	.891***	.894***
	Manual postures	---	---	.936***
	Gestures	---	---	---
C 3;0-3;5	Facial postures/expressions	---	.840***	.762**
	Manual postures	---	---	.820***
	Gestures	---	----	---

As can be seen in Table 36, analyses revealed moderate to strong significant associations between scores on the posture and gesture tasks at all ages in the clinical sample. Thus, statistical results validated the construction of the theoretically motivated ISI composite. Composite scores were derived by summing raw scores of the three posture and gesture subtests. Table 37 provides descriptive statistics for ISI composites scores according to age in the clinical sample.

Table 37: ISI composite raw scores according to age group in the clinical sample

Age group	n	Median	SD	Range (max = 41)	
				Min	Max
A (2;0-2;5)	19	1	10.83	0	30
B (2;6-2;11)	11	4	12.34	0	32
C (3;0-3;5)	15	36	15.28	0	40

3.6.2 Performance on language in the typical and clinical samples

This section presents outcomes of language measures for typical and clinical samples according to age range, in terms of standard T-scores (mean of 50, SD of 10).

Children were assessed on a range of standardised German language measures (see section 2.2.5) in order to

- confirm their allocation to typical or clinical samples; and
- provide evidence of language performance in the clinical sample as a basis for investigating relations between language and ISI.

It will be recalled that children in the clinical sample had to meet the criteria for specifically delayed language development: performance at least 1.5 SD below average on one subtest and 1.25 SD below average on another subtest on a range of standardised language assessments. The following sections describe language outcomes for each age range demonstrating that children recruited to each group met language criteria for allocation to that group and laying foundations for analyses of relations between ISI and language in the clinical sample.

2;0-2;5 YEARS

Both groups were assessed on two receptive and two expressive language measures, using the same language test (SETK-2, see section 2.2.5). Table 38 shows descriptive statistics for language scores in the typical and clinical groups, illustrated by boxplots in Figure 14.

Table 38: T-scores on language measures at age 2;0-2;5 years for typical and clinical groups

Range A: 2;0-2;5 years

Typical group (n = 20)

Language measures	Mean	SD	Range	
			Min	Max
Word receptive	56.0	7.9	41	69
Sentence receptive	55.6	5.9	41	65
Word expressive	54.1	6.4	46	70
Sentence expressive	48.6	5.7	40	58

Clinical group (n = 19)

Language measures	Mean	SD	Range	
			Min	Max
Word receptive	47.8	12.9	34	69
Sentence receptive	45.0	16.2	26	72
Word expressive	31.0	5.7	26	44
Sentence expressive	31.2	2.3	30	36

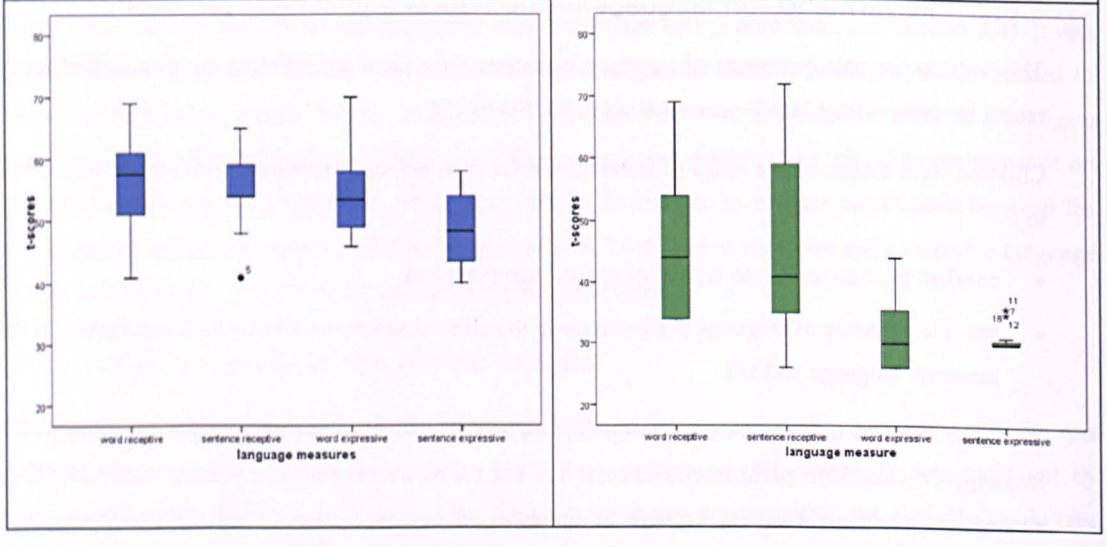

Figure 14: Boxplots of T-scores on language measures at age 2;0-2;5 years for typical and clinical groups

All children in the youngest *typical* group scored at or above a T-score of 40 (equivalent to -1 SD) on all receptive and expressive language subtests and therefore within the normal range. In the youngest *clinical* group, all children scored at or below a T-score of 38 (equivalent to -1.25 SD) on both expressive measures and therefore below the cut-off point for language delay, with the exception of 1 child in the subtest 'word expressive'. In contrast, fewer than half the children in the youngest clinical group (47.4%) scored at or below a T-score of 38 on one or both receptive measures. Thus, almost all children in the youngest clinical group showed an expressive language delay, whereas more than half of the children were not delayed on receptive language. Expressive scores of typical and clinical groups did not overlap, whereas receptive scores of children in the clinical group overlapped with scores in the typical group.

A repeated-measures ANOVA was used to test whether mean scores for language measures in the youngest clinical group differed from each other. Mauchly's test indicated that the assumptions of sphericity had been violated ($\chi^2(5) = 31.88$, $p < .001$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .55$). The results showed that the mean outcome on

language subtests was significantly affected by the type of language subtest (F (1.64, 29.59) = 15.25, $p < .001$, $\eta^2 = .46$). The Bonferroni-corrected post hoc tests revealed that, on average, children in the youngest clinical group scored significantly lower on expressive than on receptive language measures (word receptive: $p < .05$ and sentence receptive: $p < .001$ for both expressive measures). No other significant differences were found.

2;6-2;11 YEARS

Both groups were assessed on two receptive and two expressive subtests of the SETK-2. In addition to subtests administered to the youngest group, two supplementary receptive language measures were administered to children in the middle clinical group (noun and verb comprehension of the PDSS, see section 2.2.5).

Table 39 provides descriptive statistics for language scores in the typical and clinical groups, illustrated by boxplots in Figure 15.

Table 39: T-scores on language measures at age 2;6-2;11 years for typical and clinical groups

Range B: 2;6-2;11years

Typical group (n = 20)

Language measures	Mean	SD	Range	
			Min	Max
Word receptive	52.5	7.2	45	62
Sentence receptive	53.4	6.8	41	65
Word expressive	56.8	7.2	42	65
Sentence expressive	50.7	10.5	40	79

Clinical group (n = 11)

Language measures	Mean	SD	Range	
			Min	Max
Word receptive	43.9	10.9	29	62
Noun receptive	38.8	11.0	25	54
Verb receptive	40.4	9.8	26	54
Sentence receptive	42.2	9.6	26	59
Word expressive	32.8	8.6	23	50
Sentence expressive	26.9	3.5	23	33

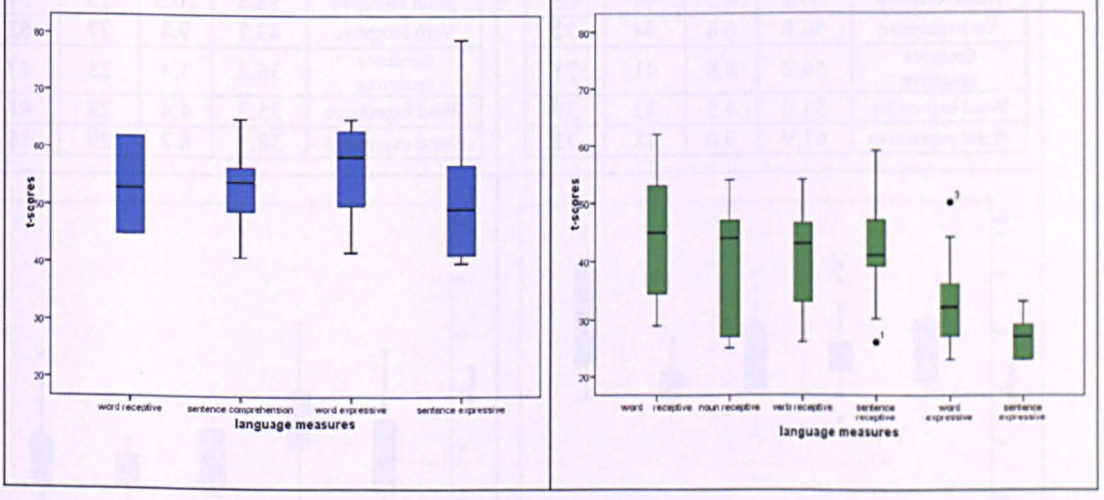

Figure 15: Boxplots of T-scores on language measures at age 2;6-2;11 years for typical and clinical groups

As found in the youngest group, all children in the middle *typical* group scored at or above a T-score of 40 on all receptive and expressive language subtests and therefore within the normal range. All children in the middle *clinical* group had difficulty producing sentences and the majority also scored below or at a T-score of 38 on the subtask 'word expressive' (81.8 %). Thus, all participants in this age group showed

expressive language difficulty, and the ability to produce sentences most clearly differentiated typical and clinical groups. In contrast, fewer than half the children in the clinical group (45.5 %) presented with an additional deficit on one or more receptive language measures. Scores of TD children and children with SLD overlapped on all receptive measures and on the subtask 'word expressive' but not on the subtask 'sentence expressive'.

A repeated-measures ANOVA was used to test whether mean scores of language measures in the middle clinical group differed from each other. Mauchly's test indicated that the assumptions of sphericity had been violated ($\chi^2(14) = 25.40$, $p < .05$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .43$). The results showed that the mean outcome on language subtests was significantly affected by the type of language subtest ($F(2.17; 21.66) = 10.45$, $p < .001$, $\eta^2 = .51$). The Bonferroni-corrected post hoc tests revealed that the mean score on the 'sentence expressive' measure was significantly lower than the mean of all receptive language measures ($p < .01$ or .05 for all comparisons). No other significant differences were found.

3;0-3;5 YEARS

The oldest typical and clinical groups were both assessed on three receptive and two expressive subtests, using the same language tests (SETK-3 and PDSS, see section 2.2.5). Table 40 provides descriptive statistics for language scores in each group, illustrated by boxplots in Figure 16.

Table 40: T-scores on language measures at age 3;0-3;5 years for typical and clinical groups

Range C: 3;0-3;5 years

Typical group (n = 20)

Language measures	Mean	SD	Range	
			Min	Max
Noun receptive	55.8	6.2	44	66
Verb receptive	56.8	6.8	44	72
Sentence receptive	56.2	8.8	41	71
Word expressive	51.2	4.5	43	59
Plural expressive	61.9	9.0	48	72

Clinical group (n = 15)

Language measures	Mean	SD	Range	
			Min	Max
Noun receptive	38.5	10.3	23	57
Verb receptive	43.7	9.8	27	62
Sentence receptive	36.2	7.4	25	47
Word expressive	35.3	4.4	28	41
Plural expressive	38.3	8.2	29	56

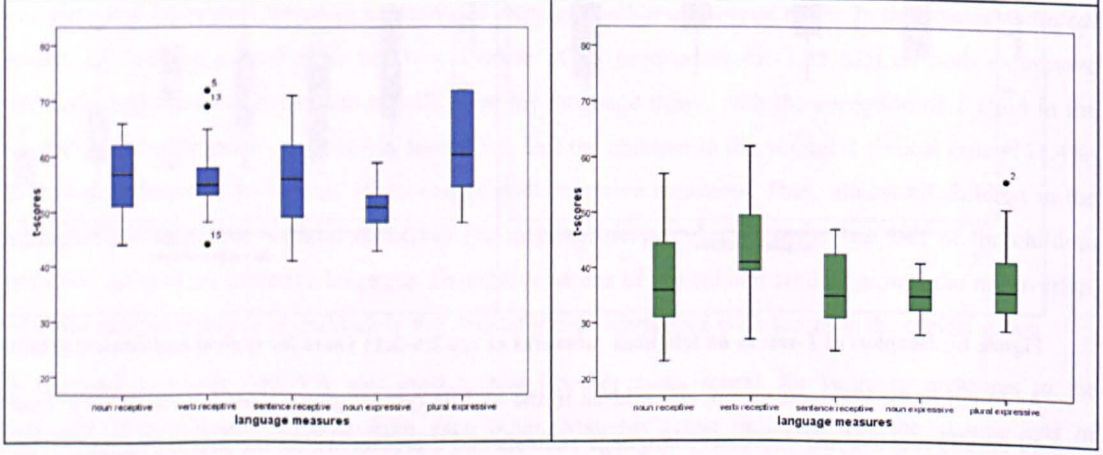

Figure 16: Boxplots of T-scores on language measures at age 3;0-3;5 years for typical and clinical groups

As found in the two younger groups, all children in the oldest *typical* group scored at or above a T-score of 40 on all receptive and expressive language subtests and therefore within the normal range (see Table 40 and Figure 16). In the oldest clinical group, approximately two-thirds of the children scored below a T-score of 38 on one or more receptive language subtests (66.6 %). A slightly higher proportion scored below the cut-off point on one or more expressive language subtests (73.3%). Hence, more children in the oldest than in the two younger clinical groups presented with receptive language difficulty and fewer with expressive language difficulty. Scores of typical and clinical groups overlapped in all language subtests.

A repeated-measures ANOVA was used to test whether mean scores of language measures in the oldest clinical group differed from each other. This time, the assumption of sphericity was satisfied ($\chi^2(9) = 14.33$, $p > .05$). Results revealed no significant overall difference in children's performance on receptive and expressive tasks ($F(4; 56) = 2.95$, $p > .05$, $\eta^2 = .17$).

As reported in the previous sections, all children in the two younger clinical groups had difficulty producing sentences. Children in the oldest age group were not assessed on their ability to produce sentences, but an assessment of their ability to produce plural marker was administered. Only 66.6 % of children in this group showed deficits in the production of plural marker. Thus, differences in children's performance could be due to different tasks used and this needs to be taken into account in terms of the identification and analysis of language profiles.

3.6.3 Receptive and expressive language composites in the clinical sample

Separate receptive and expressive composites were created for each age group since different language measures were administered at different ages and outcomes of language measures differed between age groups. To validate the construction of these composites, correlations between receptive subtests and between expressive subtests were investigated. On theoretical grounds, and following results reported in section 3.6.2, correlations were expected to be significant. To check this, Pearson's product-moment correlations were conducted between T-scores of all receptive language subtests, and between T-scores of expressive language subtests administered in the clinical sample, according to age group and controlling for children's age.

Table 41: Relations between receptive and expressive language subtests in the clinical sample according to age

Age 2;0-2;5 (n=19)				
Word receptive x sentence receptive	.731***			
Word expressive x sentence expressive	.617**			
Age 2;6-2;11 (n=11)				
	Word receptive	Noun receptive	Verb receptive	Sentence receptive
Word receptive	---	.825**	.859***	.759**
Noun receptive	---	---	.822**	.724**
Verb receptive	---	---	---	.907***
Sentence receptive	---	---	---	---
Word expressive x sentence expressive	.706*			
Age 3;0-3;5 (n=15)				
	Noun receptive	Verb receptive	Sentence receptive	
Noun receptive	---	.693**	.519*	
Verb receptive	---	---	.641*	
Sentence receptive	---	---	---	
Word expressive x plural expressive	.698**			

As can be seen in Table 41, all receptive subtests were moderately to strongly correlated, as were all expressive subtests. Thus, statistical results validated the construction of theoretically motivated receptive and expressive language composites.

Composite scores were derived by summing T-scores of all receptive subtests and all expressive subtests according to age group, and dividing each of these sums by the number of receptive/expressive subtests.

Table 42 provides descriptive statistics for receptive and expressive composite T-scores according to age in the clinical sample.

Table 42: Receptive and expressive composite T-scores according to age in the clinical sample

Age group	n	Receptive composites				Expressive composites			
		Mean	SD	Range (max=100)		Mean	SD	Range (max=100)	
				Min	Max			Min	Max
A (2;0-2;5)	19	46.42	13.41	30	71	31.11	3.64	28	40
B (2;6-2;11)	11	41.32	9.53	27	53	29.86	5.68	23	40
C (3;0-3;5)	15	39.47	7.62	25	52	36.80	5.47	29	47

3.6.4 Correlations between ISI and language composites in the clinical sample

Spearman's rho correlations were conducted between the ISI composite and the receptive and expressive language composites to test the *strength* of relations between ISI and language skills at a group level. Table 43 provides the correlation coefficients for the receptive and expressive composites according to age group.

Table 43: Relations language composites x ISI composites in the clinical sample according to age

Age range	Language composite	Correlation with ISI composite
2;0-2;5 (n=19)	Receptive composite	.076 ns
	Expressive composite	.080 ns
2;6-2;11 (n=11)	Receptive composite	.065 ns
	Expressive composite	.640*
3;0-3;5 (n = 15)	Receptive composite	.595*
	Expressive composite	.002 ns

* = $p < 0.5$

Results revealed a moderately significant relation between ISI and *expressive* language skills at 2;6-2;11 years, whereas a moderately significant relation was found between ISI and *receptive* language skills at 3;0-3;5 years. No other significant relations emerged.

Based on the mapping theory (Chiat, 2001), it was predicted that children with sociocognitive constraints, as indicated by selective difficulty with the ISI tasks, would have difficulty with understanding meaning intentions behind utterances that would result in difficulties with language, most notably receptive language. Results of the oldest group are in line with these predictions. However, results of the two younger groups are not in keeping with these predictions, since no significant relations between ISI and language skills emerged in the youngest group, and contrary to predictions significant associations were found between ISI and expressive language only in the middle group. Thus, different relations between ISI and language emerged at each age level, in line with previous findings of different profiles of language and ISI performance at different age ranges.

However, it is possible that putative relations between *profiles at an individual level* were masked by merely investigating relations between *skills at a group level.* The next step was therefore to investigate specific relations between different profiles of ISI and language.

3.7 Relations between profiles of ISI and language in the clinical sample

It was expected that some, but not necessarily all, children in the SLD sample would have difficulty with measures of ISI. In line with this prediction, scores of typical and clinical groups on measures of ISI were found to show some overlap (see section 3.4.1), confirming that not *all* children with SLD performed below TD peers. ISI profiles, in contrast to the ISI composite, tell us how each child in the clinical sample performed on ISI, and therefore which and how many children in the clinical groups performed more poorly than TD peers or like TD peers.

Likewise, language composites, do not tell us which and how many children with receptive language delay also had expressive language delay and which and how many children had purely receptive or expressive language delay. In contrast, language profiles *specify* receptive and expressive language skills and deficits for each child. Based on the sociocognitive hypothesis, it was predicted that children with purely *receptive* language delay and *combined receptive and expressive* language delay would show sociocognitive constraints, as indicated by measures of ISI, whereas children with purely *expressive* language difficulty were not expected to show sociocognitive constraints (see section 1.4). In order to investigate these predictions, profiles of ISI (see section 3.7.1) and profiles of language (see section 3.7.2) were identified in the clinical sample, and relations between these profiles were analysed for each age range (see section 3.7.3).

3.7.1 ISI profiles

ISI performance of children in the clinical sample was categorised as low, borderline or typical, based on performance across the three posture and gesture tasks. Cut-offs were based on distribution of raw scores within the clinical sample and comparison to the distribution in the typical sample, according to age group (raw scores can be found in section 3.4.1):

- **Low:** scores below the minimum score of the typical group and below the median score of the clinical group on at least two out of three posture and gesture tasks, i.e. children are *outside* the typical range, and in the *lower half* of the clinical range.
- **Borderline:** scores at or above the median score of the clinical group but below the minimum score of the typical group (excluding scores of outliers in the youngest TD group) on at least two out of three posture and gesture tasks, i.e. children are *outside* the typical range, but in the *upper half* of the clinical range.
- **Typical:** scores overlap with scores of TD participants (excluding scores of outliers in the youngest TD group) on at least two out of three posture and gesture tasks.

The same categories applied for all age groups.

Table 44 shows the distribution of these profiles for each age group.

Table 44: Percentage of participants with each ISI profile, according to age group

	Low	Borderline	Typical
2;0-2;5 (n=19)	68.4%	21.1%	10.5%
2;6-2;11 (n=11)	45.5%	45.5%	9.0%
3;0-3;5 (n=15)	33.3%	0.0%	66.6%

The majority of children in the *youngest clinical group* met criteria for the low ISI profile (n=13), and all children with this profile were refusers on at least two out of three ISI tasks. Most children who complied with the tasks had a borderline ISI profile (n=4), and just 2 children had a typical ISI profile.

In the *middle age group*, equal numbers of children had low (n=5) and borderline (n=5) ISI profiles. Only 1 child achieved a typical ISI profile. As in the youngest group, all children with a low profile refused to comply with at least two out of three ISI tasks.

Only one third of participants in the *oldest clinical group* had a low ISI profile (n=5), and the remaining two-thirds had a typical ISI profile (n=10). Thus, no child was identified with a borderline ISI profile. Of the 5 children with low ISI profiles, 3 refused to comply with any ISI task while 2 attempted at least some items of each ISI task.

Overall, results again demonstrate the shift from low ISI performance with high levels of non-compliance in the youngest clinical group to typical levels of performance of two-thirds of participants in the oldest clinical group.

3.7.2 Language profiles

Language profiles of children in the clinical sample were derived from all language subtests administered at each age range, using a cut-off of -1.25 SD to define delay on each subtest. Three different language profiles were identified:

- **Receptive language delay**: language performance ≤ -1.25 SD on at least *two* receptive measures and > -1.25 SD on all expressive measures
- **Expressive language delay**: language performance ≤ - 1.25 SD on both expressive language measures and > -1.25 SD on all receptive measures
- **Combined delay**: language performance ≤ -1.25 SD on at least one receptive and one expressive language measure.

The same profiles applied for all age groups. Since specific language delay was defined by performance at least 1.5 SD below average on one subtest and 1.25 SD below average on another subtest, by definition, each participant scored at least 1.25 SD below average on two language subtests.

Table 45 shows the resulting distribution of language profiles in each age group.

Table 45: Percentage of participants with each language profile, according to age group

	Receptive delay	Expressive delay	Combined delay
2;0-2;5 (n=19)	0.0%	42.1%	57.9%
2;6-2;11 (n=11)	0.0%	54.5%	45.5%
3;0-3;5 (n=15)	13.3%	20.0%	66.7%

Since all children in the *youngest clinical group* showed delayed expressive language skills (see section 3.6.2), participants in this group presented with combined and expressive but not with receptive language profiles. Eleven children had a combined language profile and 8 participants had an expressive language profile.

Likewise, all children in the *middle clinical group* showed expressive language difficulties (see section 3.6.2) and therefore presented with either combined or expressive but not with receptive language profiles. Approximately half had combined (n=5), and half expressive (n=6) language profiles.

In contrast to the two younger groups, all three language profiles occurred in the *oldest clinical group*. Two-thirds of participants emerged with combined (n=10), and the rest were split between expressive (n=3) and receptive (n=2) language profiles. In considering receptive profiles, it has to be kept in mind that expressive measures for this group did not include a sentence production test, and this might have influenced expressive language outcomes (see section 3.6.2). However, this does not affect the finding that these children had severe receptive language deficits.

3.7.3 Relations between ISI and language profiles

Relations between profiles of ISI and language were investigated using Fisher's Exact Test. In addition, observed combinations of ISI and language profiles were explored more closely for patterns that might possible give more insight into relations between ISI and language and implications for underlying deficits.

2;0-2;5 YEARS

Figure 17 provides a breakdown of how many participants with expressive and combined language profiles had low, borderline and typical ISI profiles in the youngest clinical group.

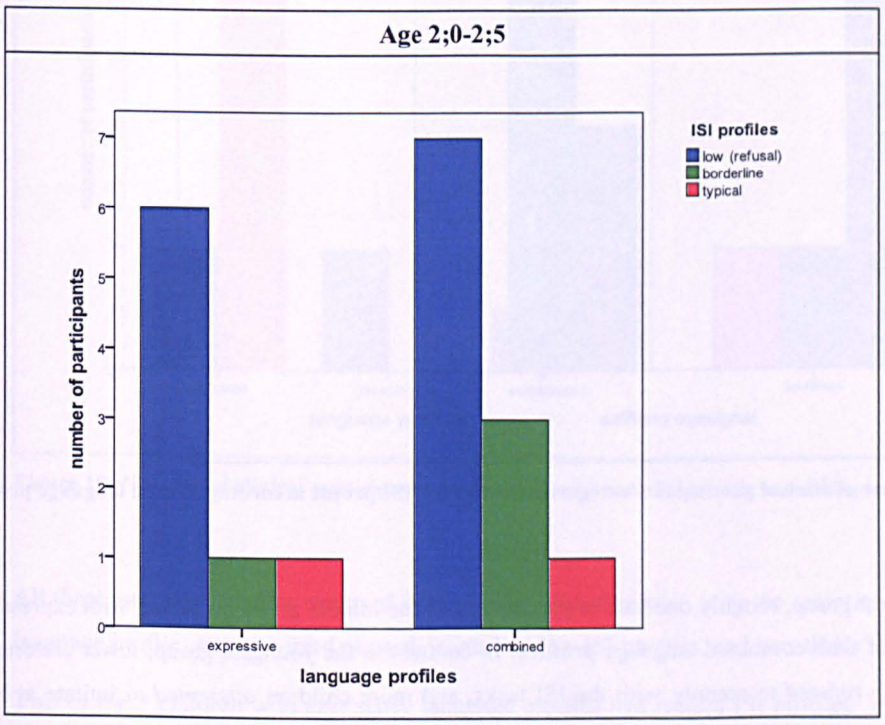

Figure 17: Number of clinical participants categorised with each ISI profile according to each language profile

As reported previously, roughly half the participants in the youngest group presented with expressive, the other half with combined language profiles, and the majority of children performed *low* on ISI due to refusal. A similar number of children with low, borderline and typical ISI profiles were associated with each language profile. Accordingly, Fisher's Exact Test revealed no significant association between profiles of ISI and language. Thus, contrary to predictions but in line with results of correlational analyses, profiles of performance on ISI and language were not significantly associated in this group.

2;6-2;11 YEARS

Figure 18 provides a breakdown of how many participants with combined and expressive language profiles had low, borderline and typical ISI profiles in the middle clinical group.

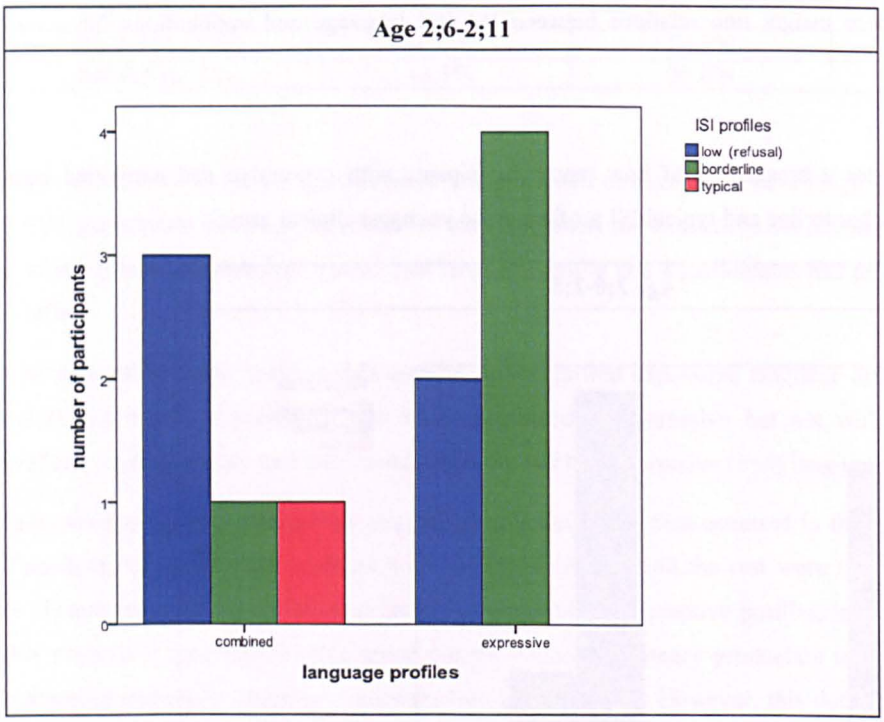

Figure 18: Number of clinical participants categorised with each ISI profile according to each language profile

As in the youngest group, roughly one half of participants in the middle group presented with expressive, and the other half with combined language profiles. In contrast to the youngest group, fewer children in the middle group *refused* to comply with the ISI tasks, and more children *attempted* to imitate at least some target acts of each ISI task, although they still achieved lower scores than TD peers. A similar number of children with *low* ISI profiles occurred with each language profile, but more participants with *borderline* ISI profiles had expressive than combined language profiles. However, Fisher's Exact Test revealed no significant association between ISI and language profiles.

Closer inspection of individual profiles revealed that the 5 children who scored most poorly on ISI also achieved the lowest expressive language scores. More specifically, children who refused the posture and gesture tasks were not credited with *any* correct expressive language item, irrespective of language profile. This is in line with results of correlational analyses which showed moderately significant relations between ISI and expressive language skills. Thus, again contrary to predictions, but in line with results of correlational analyses, there appeared to be a relation between the *severity* of children's expressive language and ISI problems.

3;0-3;5 YEARS

Figure 19 provides a breakdown of how many participants with combined, receptive and expressive language profiles had low and typical ISI profiles in the oldest clinical group.

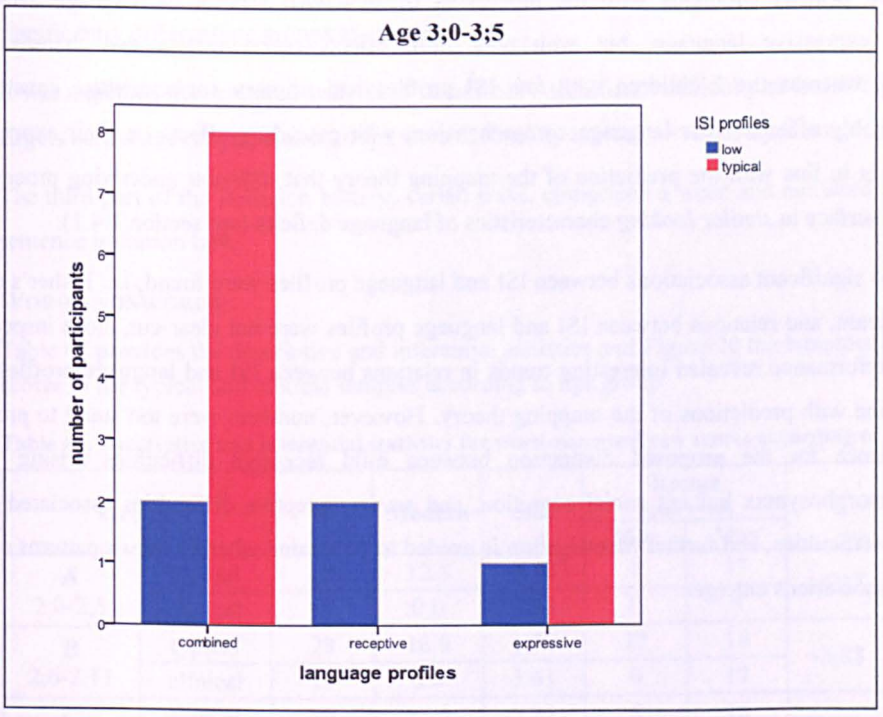

Figure 19: Number of clinical participants categorised with each ISI profile according to each language profile

All three language profiles occurred in the oldest clinical group, with the majority showing a combined language profile. Just one-third of participants had low ISI profiles, and two-thirds typical.

Two of the 3 children with *expressive* language profiles had *typical* ISI profiles. This is in line with the predictions of the mapping theory, since children with pure expressive language difficulty with deficits in syntax and morphology at its core are expected to have difficulty with the processing of structural aspects of language, but not with social cognition. However, contrary to predictions, the third child with an *expressive* language profile had a *low* ISI profile.

The 2 children with *receptive* language profiles had *severe* receptive language difficulties with scores < -2.0 SD on receptive language subtests and were identified with *low* ISI profiles. This is in line with the prediction of the sociocognitive hypothesis, since children with sociocognitive constraints are expected to have difficulty with discovering the meaning of language.

The majority of children with *combined* language profiles had *typical* ISI profiles, but 2 children emerged with *low* ISI profiles. Closer inspection of children's performance revealed that the combined language profiles of children with *low* ISI profiles had different characteristics than the combined language profiles of children with *typical* ISI profiles. The 8 children with *typical* ISI profiles had *relatively mild* receptive language difficulties, with scores > -2.0 SD on receptive language subtests, and receptive language was

on a par with or better than expressive language. In contrast, the 2 children with *low* ISI profiles had *severe* receptive language difficulties, with scores < -2.0 SD on receptive language subtests, and receptive language was poorer than expressive language. Thus, it might be argued that the 8 children with *typical* ISI profiles had primary problems with the processing of *structural* aspects of language affecting receptive *and* expressive language, but with only mild effects on semantics and therefore on comprehension, whereas the 2 children with *low* ISI profiles had primary *sociocognitive* constraints which most notably affected their language comprehension, with cascading effects on their expressive language. This is in line with the prediction of the mapping theory that *different* underlying processing difficulties can surface in *similar looking* characteristics of language deficits (see section 1.4.1).

Hence, while no significant associations between ISI and language profiles were found, i.e. Fisher's exact was non-significant, and relations between ISI and language profiles were not clear-cut, close inspection of children's performance revealed interesting trends in relations between ISI and language profiles that are mostly in line with predictions of the mapping theory. However, numbers were too small to provide sufficient evidence for the proposed distinction between mild receptive difficulties arising from limitations in morphosyntax but not social cognition, and severe receptive difficulties associated with sociocognitive difficulties, and further investigation is needed to determine whether robust patterns of ISI and language associations emerge.

3.8 Verbal imitation

A subsidiary aim of this study was to compare the performance of groups of TD children and children with SLD on a range of verbal imitation tasks to investigate whether verbal imitation behaviours would significantly differentiate groups at all ages.

It was expected that children with SLD would have significant difficulty to imitating all types of verbal targets across age ranges, since groups were defined by typical versus delayed language development.

The third part of the imitation battery, verbal tasks, comprised a word and nonword imitation task and a sentence imitation task.

WORDS-NONWORDS

Table 46 provides the descriptive and inferential statistics and Figure 20 the boxplots for word-nonword scores in the typical and clinical samples according to age group.

Table 46: Descriptive and inferential statistics for word-nonword raw scores according to group and age

Group		n	Median	SD	Range (max = 18)		z	p	r
					Min	Max			
A 2;0-2;5	typical	20	12.5	4.30	1	17	-5.37	.001	-.86
	clinical	19	0.0	2.23	0	8			
B 2;6-2;11	typical	20	16.0	1.79	12	18	-3.88	.001	-.69
	clinical	11	8.0	5.61	0	17			
C 3;0-3;5	typical	20	17.0	2.23	8	18	-4.6	.001	-.77
	clinical	15	10.0	5.13	0	16			

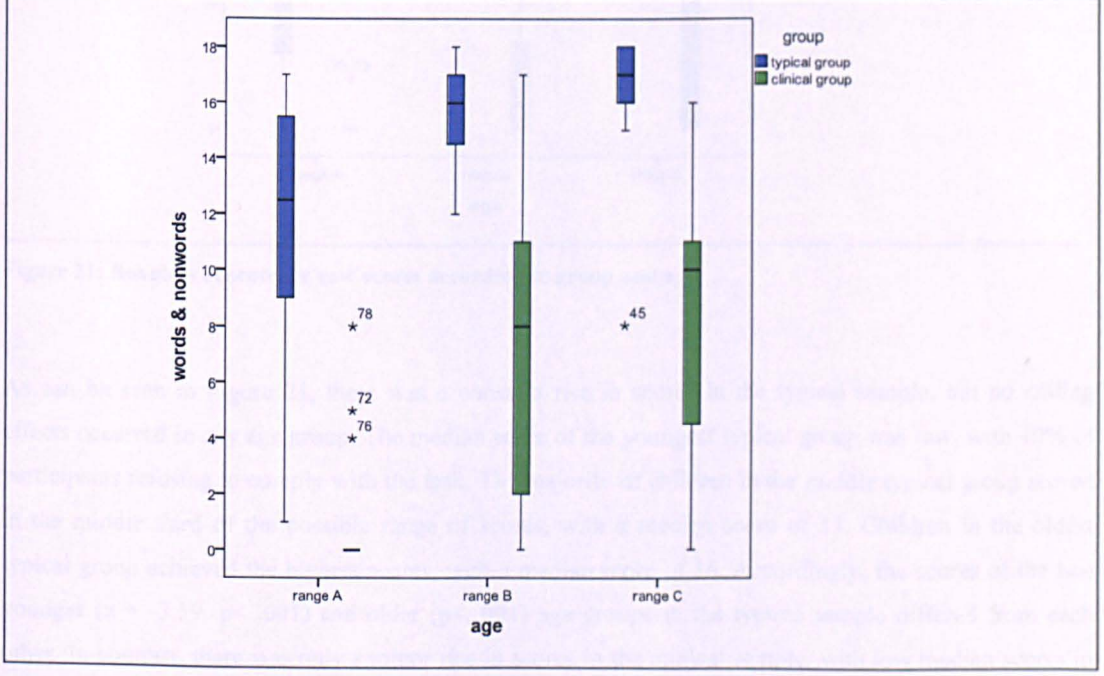

Figure 20: Boxplots for words-nonwords raw scores according to group and age

As can be seen in Figure 20, ceiling effects were evident in the two older groups in the typical sample. The majority of children in the youngest typical group scored within the upper third of the possible range. In contrast, the median score of the youngest group in the clinical sample was zero, with 84.2% of participants refusing to comply with the task. However, 3 children achieved higher scores and emerged as extreme outliers. The median score of the two older groups in the clinical sample was 8.0 and 10.0 respectively, with 18.2 % and 20.0 % of participants respectively refusing to comply with the task. Thus, children with SLD in the two older groups performed much better than children with SLD in the youngest group. The differences between the typical and clinical samples were significant for all ages (see Table 46), and effect sizes were large in all cases. As might be expected from the box plot in Figure 20, the scores of the two younger age groups in the typical ($z = -3.14$, $p < .01$) and clinical ($z = -3.65$, $p < .001$) samples differed from each other. So did the scores of the two older age groups in the typical ($z = -2.15$, $p < .05$) but not in the clinical sample.

SENTENCES

Table 47 provides the descriptive and inferential statistics and Figure 21 the boxplots for sentence scores in the typical and clinical samples according to age group.

Table 47: Descriptive and inferential statistics for sentence raw scores according to group and age

Group		n	Median	SD	Range (max = 20)		z	p	r
					Min	Max			
A 2;0-2;5	typical	20	4.5	2.72	0	11	-5.12	.001	-.82
	clinical	19	0.0	0.74	0	2			
B 2;6-2;11	typical	20	13	3.44	7	19	-4.51	.001	-.81
	clinical	11	1	2.39	0	7			
C 3;0-3;5	typical	20	16	2.17	12	20	-5.02	.001	-.85
	clinical	15	5	3.31	0	11			

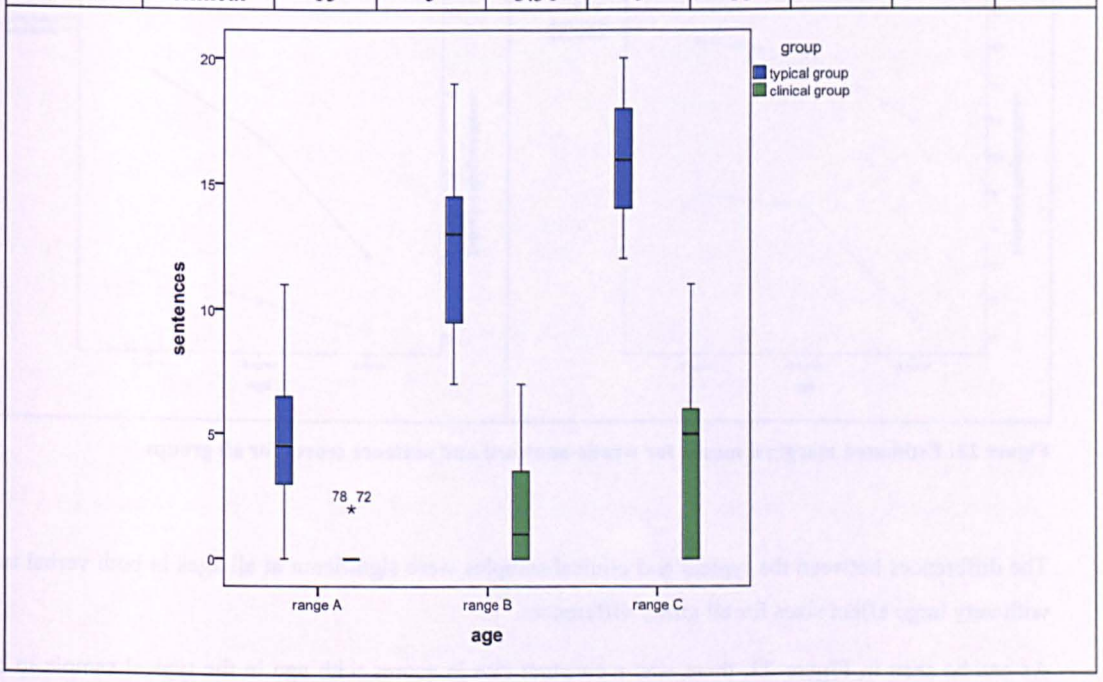

Figure 21: Boxplots of sentence raw scores according to group and age

As can be seen in Figure 21, there was a constant rise in scores in the typical sample, but no ceiling effects occurred in any age group. The median score of the youngest typical group was low, with 10% of participants refusing to comply with the task. The majority of children in the middle typical group scored in the middle third of the possible range of scores, with a median score of 13. Children in the oldest typical group achieved the highest scores, with a median score of 16. Accordingly, the scores of the two younger ($z = -3.59$, $p < .001$) and older ($p <. 001$) age groups in the typical sample differed from each other. In contrast, there was only a minor rise in scores in the clinical sample, with low median scores in all age groups. Floor effects were evident in the youngest clinical group, with 84.2 % of participants refusing to comply with the task. Two children of the group achieved higher scores and emerged as extreme outliers. The median score of the two older clinical groups were 1 and 5 respectively and thus

only slightly higher than in the youngest clinical group. However, a smaller percentage of participants in the two older clinical groups than in the youngest clinical group refused to comply with the task (36.4 % and 33.3 % respectively). The scores of the two younger ($z = -2.72$, $p < .01$) but not the two older age groups in the clinical sample differed from each other. The differences between the typical and clinical samples were significant at all ages, with large effect sizes in all cases (see Table 47).

SUMMARY VERBAL TASKS

Figure 22 provides line graphs showing estimated marginal means for words-nonwords and sentences scores in the typical and clinical samples according to age group.

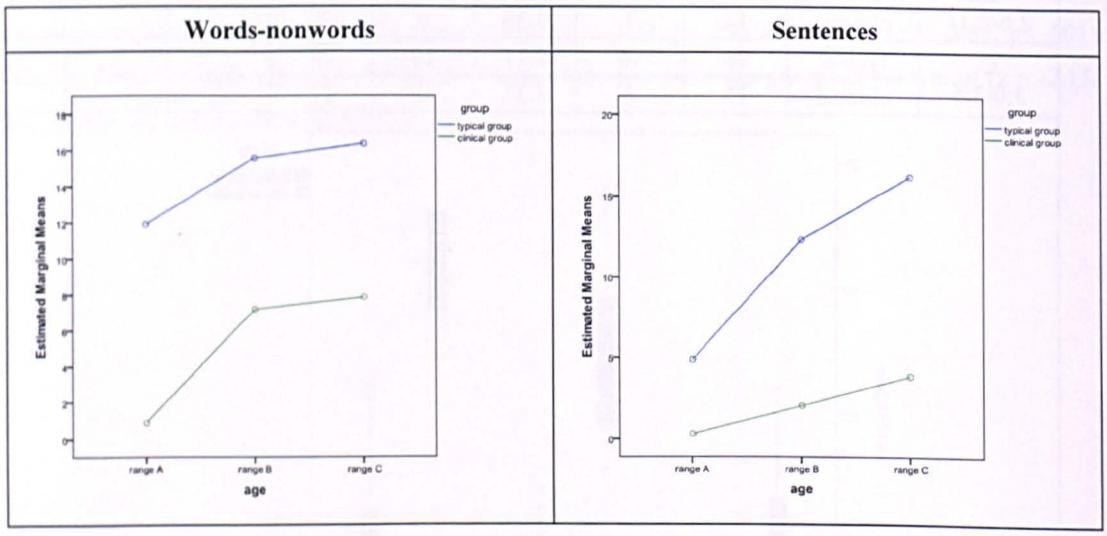

Figure 22: Estimated marginal means for words-nonword and sentence scores for all groups

The differences between the typical and clinical samples were significant at all ages in both verbal tasks, with very large effect sizes for all group differences.

As can be seen in Figure 22, there was a constant rise in scores with age in the typical sample in both verbal tasks. Overall, the mean word-nonword scores were higher than the mean sentence scores across age ranges. In the clinical sample, the youngest group scored at floor in both verbal tasks. Children in the two older groups performed much better than children in the youngest group on the word-nonword task but mean scores remained low across age groups on the sentence task. In both verbal tasks, substantially more children refused to comply with the tasks in the youngest than in the two older groups. Due to some higher scoring outliers in the clinical group, scores of children in the youngest typical and clinical groups overlapped in both verbal tasks (see Figure 20 and Figure 21). Scores of children in the two older typical and clinical groups overlapped in the word-nonword task but not in the sentence task. There was a similar distribution of scores in the youngest typical and the oldest clinical groups in both verbal tasks.

In summary, both verbal tasks differentiated typical and clinical groups across age. These results are in line with the expectation that children with SLD would have difficulty imitating both types of verbal stimuli. The sentence imitation task most clearly differentiated typical and clinical samples, since hardly

any overlap of scores occurred between TD children and children with SLD. Sentence imitation was the more demanding task: While the imitation of words and nonwords was robust for the majority of children in the typical sample, the imitation of sentences was more of a challenge for these children, particularly in the youngest group.

3.9 Response to ISI and verbal imitation and relations to language in the clinical sample

As reported in the previous sections, a substantial percentage of children in the younger and a smaller percentage in the oldest SLD groups refused the ISI tasks, and it was found that the significant difference between the TD and SLD samples on the ISI tasks stemmed from non-compliance and not from incorrect responses. Thus, it appears that once children in the SLD sample attempted to reproduce postures and gestures, they were as competent as TD peers. As in the ISI tasks, a substantial percentage of children in the younger and a smaller percentage in the oldest SLD groups refused the verbal tasks. But in contrast to the ISI tasks, the majority of children with SLD performed more poorly than TD children on verbal imitation regardless whether they refused or attempted items, particularly on the sentence imitation tasks where scores of TD and SLD groups hardly overlapped. Thus, it appears that once children in the SLD groups attempted to reproduce verbal target acts, and particularly sentences, they reproduced them incorrectly. This is not surprising since children in the clinical sample had SLD, and verbal imitation is known to be impaired in SLD and has been proposed as a marker of SLI.

Intention-sensitive nonverbal imitation is assumed to be indicative of sociocognitive capacities, whereas verbal imitation is assumed to tap constraints with the processing of the structural aspects of language as the content of imitation. Given these assumptions, refusal of ISI tasks reflects difficulty with social cognition and incorrect verbal responses reflect difficulty with language. However, the finding that a substantial percentage of children also *refused* the verbal imitation tasks raised the question whether children's performance on verbal imitation might *in addition* be influenced by putative constraints on sociocognitive processing. Since the repetition of verbal items involves no objects, produces no observable functional outcome and requires inferencing of the intended social benefit, it shares characteristic features with *intention-sensitive* nonverbal imitation. Thus, it is possible that children refuse verbal imitation because of their difficulty with language *or* because of their difficulty with the sociocognitive demands of the imitation task *or* because of difficulties with both.

This issue was approached by exploring how children in the clinical sample responded to ISI *and* verbal imitation, i.e. whether they refused or attempted the ISI and/or verbal imitation tasks, and how the pattern of 'overall imitation responses' related to language profiles.

As a first step, ISI/verbal imitation performance of children in the clinical sample was categorised as 'refusal' or 'attempt', based on performance across all tasks in each category (ISI and verbal imitation):

- **Refusal**: refusal of *all* tasks in each category (ISI = three tasks; verbal imitation = two tasks; if children produced no more than two attempts on *one* out of the whole set of tasks in each category they were categorised as refuser)
- **Attempt**: attempt to reproduce more than two items on one task in each category.

The same categories applied for all age groups.

Table 48 shows the percentage of participants for each age group who refused versus attempted all ISI tasks and who refused versus attempted all verbal imitation tasks.

Table 48: Percentage of participants who refused or attempted ISI / verbal tasks, according to age group

	ISI tasks		Verbal imitation tasks	
	Refusal	Attempt	Refusal	Attempt
2;0-2;5 years (n=19)	68.4%	31.6%	84.2%	15.8 %
2;6-2;11years (n=11)	45.5 %	54.5%	36.4%	63.6%
3;0-3;5 years (n=15)	20.0 %	80%	13.3%	86.6%

In the *youngest* group, more than two-thirds of participants refused both ISI and verbal imitation tasks, with fewer children refusing ISI than verbal imitation tasks. In the *middle* and the *oldest* groups, similar percentages of participants refused ISI and verbal imitation tasks, reducing with age.

As a second step, four patterns of 'overall imitation responses' were identified.

Two matched patterns:

- ISI and verbal imitation refused (matched refusal)
- ISI and verbal imitation attempted (matched attempt).

Two mismatched patterns:

- ISI refused, but verbal imitation attempted
- ISI attempted, but verbal imitation refused.

Table 49 shows the distribution of these 'overall imitation responses' for each age group.

Table 49: Number of participants who presented with each overall imitation response, according to age group

Overall imitation profile	Matched refusal	Matched attempt	Mismatched: ISI refused & verbal attempted	Mismatched: ISI attempted & verbal refused
2;0-2;5 (n=19)	n=12	n=2	n=1	n=4
2;6-2;11 (n=11)	n=4	n=6	n=1	n=0
3;0-3;5 (n=15)	n=1	n=11	n=2	n=1

The majority of participants in the youngest group *refused* ISI and verbal imitation tasks (63.2%), whereas the majority of participants in the oldest group *attempted* ISI and verbal imitation tasks (73.3%). In the middle group, approximately as many children *refused* as *attempted* ISI and verbal imitation tasks. Children who refused ISI but attempted verbal imitation tasks were rare, but 1 child in the youngest and the middle and 2 children in the oldest group presented with this profile, and a fifth of participants in the *youngest*, no child in the middle, and just 1 child in the oldest group attempted the ISI but refused the verbal imitation tasks. Thus, the majority of participants either refused or attempted imitation tasks, regardless whether the content was nonverbal or verbal, but response changed with age from *refusal* in the youngest group to *attempt* in the oldest group. In contrast, mismatched response to ISI and verbal imitation was relatively rare.

Having identified patterns of overall imitation responses, relations to profiles of language were explored at each age range. Interestingly, implications of relations between overall imitation responses and language were in line with implications of relations between ISI and language reported in section 3.7.3. No meaningful associations between different patterns of overall imitation responses and different language profiles were found in the *two younger groups*: a similar number of children with combined and expressive language profiles presented with each pattern of overall imitation responses, and there were no children with receptive language profiles. In contrast, interesting trends in relations between overall imitation responses and language were observed in the *oldest* group:

Matched refusal

The only child who refused ISI and verbal imitation tasks had a receptive language profile. Thus, it might be argued that this child had primary difficulty with *social cognition*, and therefore refused all tasks due to the sociocognitive demands of the imitation format, regardless whether the content was nonverbal or verbal.

Matched attempt

Eleven children attempted ISI and verbal imitation tasks, but they all had difficulty at least with sentence imitation. Nine of these children had combined language profiles, while 2 had expressive. Thus, it might be argued that these children had primary difficulty with the *structural aspects of language* and less with social cognition, and therefore attempted to reproduce nonverbal and verbal targets. However, 2 children had combined language profiles with severe receptive language difficulty, and in section 3.7.3 it was argued that these children had primary *sociocognitive constraints* which most notably affected their language comprehension, with cascading effects on their expressive language. In line with this argumentation, these 2 children had *low* ISI profiles, i.e. they attempted a few but refused most postures and gestures, whereas all other children with combined language profiles and relatively mild receptive difficulty had *typical* ISI profiles.

Mismatched: ISI refused and verbal imitation attempted

Two children refused ISI but attempted verbal imitation tasks and it might be assumed that these children had primary problems with social cognition and less problem with the structural aspects of language. In line with this assumption, 1 child had a receptive language profile, but contrary to this assumption, the other child had an expressive language profile.

Mismatched: ISI attempted and verbal imitation refused

Finally, the only child who attempted ISI but refused verbal imitation tasks had a combined language profile with relatively mild receptive difficulty. Thus, it might be argued that this child had primary difficulty with the structural aspects of language but not with social cognition, and therefore refused the verbal imitation tasks due to the linguistic demands of the verbal content and not because of the sociocognitive demands of the imitation format.

This exploration of relations between patterns of overall imitation performance and profiles of language points to the possibility that children in the 3-year-old group refused verbal imitation not only because of their difficulty with language, but also because of their difficulty with social cognition. Thus, verbal imitation tasks might not only tap skills in processing structural aspects of language, but also sociocognitive capacities. However, further and more in depth investigation are necessary to evaluate this proposed hypothesis.

Turning to the 2-year-old groups, it was particularly interesting that the imitation of postures and gestures was as challenging as the imitation of verbal targets for most participants in the youngest group, whereas more than half the participants in the middle group attempted ISI and verbal tasks.

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4 Discussion

This thesis examined the imitation abilities of 2;0-3;5-year-old children with SLD.

The following questions were addressed:

- Is there a significant difference in nonverbal imitation performance between TD and SLD groups at different age ranges?

It was hypothesised that some children with SLD would have difficulty with nonverbal imitation tasks categorised as ISI, while nonverbal imitation tasks identified as OSI would be no more challenging for children with SLD than TD children.

- Do types and rates of nonverbal error patterns in the oldest SLD group resemble those in the youngest TD group?

In analysing error patterns, refusal to attempt *specific* target acts, i.e. *selective* non-compliance, was considered as evidence of difficulty rather than uncooperativeness.

- Is performance on ISI, as an indicator of sociocognitive abilities, related to performance on language within the SLD sample at each age range?

It was hypothesised that children with exclusive receptive language delay and combined receptive and expressive language delay would show constraints on ISI, whereas children with exclusive expressive language delay would not.

The following subsidiary question was addressed:

- Is there a significant difference in verbal imitation performance between TD and SLD groups at different age ranges?

It was hypothesised that children with SLD at all age ranges would have significant difficulties with word, nonword and sentence imitation tasks.

In addition, relations between performance on ISI and verbal imitation were explored in the clinical sample.

4.1 Summary of results

4.1.1 Nonverbal imitation

A group study systematically compared the performance of TD children and children with SLD on a range of nonverbal imitation tasks. Children were divided into three age groups (A = 2;0-2;5 years, B = 2;6-2;11 years, C = 3;0-3;5 years).

Table 50 presents a summary of which measures differentiated typical and clinical groups according to age. It can be seen that performance was linked to the *type* of task and the *age* of participants.

Table 50: Results of between groups analyses according to task and age

Type of measure	Task	Age	Group difference?
ISI measures: Postures & gestures	Facial postures & expressions	A	✓***
		B	✓***
		C	✓**
	Manual postures	A	✓***
		B	✓***
		C	✓*
	Gestures	A	✓***
		B	✓***
		C	X
OSI measures: Common Instrumental acts	Instrumental acts with familiar objects	A	X
		B	X
		C	X
	Item 'touching dolphin'	A	✓*
		B	✓**
		C	✓*
	Instrumental acts with unfamiliar objects	A	X
		B	X
		C	X
Subtasks	Subtask 1 (Action details)	A	X
		B	X
		C	X
	Subtask 2 (Rational imitation)	A	X
		B	X
		C	X
Hybrid measure:	Pretend acts with substitute objects	A	✓**
		B	✓***
		C	X

✓= significant; X = not significant; *= p<.05, **= p< .01, ***= p ≤ .001

As predicted, significant differences between TD and SLD groups were found on all **posture and gesture tasks** for almost all age ranges. The majority of TD children, with the exception of 2 very young boys, completed posture and gesture tasks with little difficulty, whereas the majority of the 2-year-old and a fifth of the 3-year-old children with SLD had substantial problems. A large percentage of low scores in the clinical sample were due to non-compliance. Despite marked group differences, overlap between ranges of performance within the typical and clinical groups occurred, revealing that some children with SLD performed like TD peers. These findings are in line with the prediction that some children with SLD

would have difficulty imitating intention-sensitive target acts, since these measures were assumed to be indicative of sociocognitive capacities, and it was expected that the clinical groups would include children with such difficulties. Children in the oldest clinical group performed significantly better than children in the middle clinical group on all posture and gesture tasks. Thus, performance on all ISI measures was group - and age - sensitive. Further, a significant interaction between age and language status was found.

In order to investigate whether children's imitation of body movements would be influenced by the factor 'meaning not conveyed' versus 'meaning conveyed', performance of TD and SLD groups was compared on manual postures, which do not convey meaning, and on gestures, which convey meaning, but this distinction was not found to affect either group.

In contrast to measures of ISI, it was predicted that nonverbal imitation tasks identified as outcome-sensitive would be no more challenging for children with SLD than for TD children, since measures were assumed to be relatively independent of sociocognitive capacities. In line with this prediction, TD and SLD groups at all age ranges had almost no difficulty attempting and reproducing common **instrumental acts**, with the expectation of one item, 'touching dolphin', to which clinical and typical groups responded significantly differently. This led to a reconsideration of this item and the conclusion that it had been incorrectly classified. Thus, children's difficulty with imitating this *specific* item turned out to be informative about the nature of the imitation deficit in children with SLD.

Findings of research with children with ASD had raised the question whether the *unfamiliarity* of objects would influence the ability of children to imitate instrumental acts on objects. To explore this question, performance of TD and SLD groups was compared on common instrumental act with *familiar* objects and common instrumental acts with *unfamiliar* objects, but there were no group differences. Thus, children's performance on instrumental acts was not influenced by familiarity of objects.

Previous research involving TD children and children with ASD had also raised the question whether some children with SLD would have difficulty imitating unnecessary action details (Subtask 1) and/or adapting their imitative response based on possible rationales for the demonstrator's action (Subtask 2). No significant differences were found between groups on either **subtask**.

Pretend acts on substitute objects had been classified as a hybrid measure, since these acts involved real objects without coming to an observable functional outcome. Significant differences were found between the 2-year-old but not the 3-year-old TD and SLD groups. The majority of children in the TD sample had no or little difficulty imitating pretend acts, whereas some children in the two younger SLD groups had problems, demonstrated by substantial overlap between the typical and clinical groups. Overall, the pattern of results for pretend acts was similar to the pattern of results for posture and gesture tasks, but 2-year-old children with SLD were more likely to comply with the pretend act than the posture and gesture task, resulting in higher median scores and a wider overlap between scores of typical and clinical groups. Findings are in line with categorisation as a hybrid measure, since the imitation of pretend acts was less difficult than the intention-sensitive postures and gestures but more problematic than the outcome-sensitive instrumental acts.

In summary, groups with SLD performed significantly below TD groups on some, but importantly not all, nonverbal imitation tasks. Significant group differences were found on all posture and gesture tasks, the task pretend acts on substitute objects and the item 'touching dolphin'. However, performance on these tasks was age-sensitive, with children in the oldest clinical group performing significantly better than children in the middle clinical group, as demonstrated by weaker or even non-significant differences between the 3-year old TD and SLD groups. In contrast, no significant group differences emerged for the common instrumental act tasks or the two subtasks.

4.1.2 Nonverbal Imitation errors

Patterns of nonverbal imitation errors were analysed within the SLD sample and compared to patterns of nonverbal imitation errors in the TD sample.

In this study, *selective* non-responding was assumed to be evidence of difficulty rather than uncooperativeness and children's non-responses were scored as zero and included in the dataset. In line with this assumption it was found that children in the clinical sample showed a pattern of *selective* non-compliance affecting those nonverbal imitation tasks that were expected to be difficult for some children with SLD, rather than *general* non-compliance affecting the whole imitation battery. No child refused all tasks, since refusal occurred in the ISI and hybrid measures (postures, gestures, pretend acts), but not in the OSI measures (instrumental acts). Furthermore, non-compliance occurred most frequently in the ISI, less frequently in the hybrid and only occasionally for individual items in the OSI measures.

Both types of errors, *non-compliance* and *incorrect responses*, occurred in the typical *and* clinical samples, and furthermore on the same nonverbal imitation tasks in both samples. The majority of incorrect responses in both samples were partial errors, i.e. responses that shared some features with the demonstration, and almost all types of partial error in the SLD sample resembled those of the TD sample (see Appendix D). An exception was the item 'touching dolphin', which elicited different and unexpected responses in the SLD sample. *Unrelated errors*, i.e. responses that shared no features with the modelled act, occurred only in the clinical sample, but were rare and could be viewed as very extreme rather than completely unrelated errors. Thus, the majority of errors occurring in the SLD sample resembled those in the TD sample rather than being qualitatively different.

Furthermore, a comparison of *types* and *rates* of error revealed that error patterns in the *oldest clinical group* resembled those in the *youngest typical group* across tasks: refusal-rates were low and non-responses did not occur in the posture and gesture tasks, whereas occasional non-responses but no refusal occurred in the instrumental acts tasks, and levels of incorrect responses were similar according to task. This suggests a delayed rather than deviant pattern of response on these tasks.

Interestingly, different patterns of error in terms of levels of incorrect responses and non-compliance emerged for tasks categorised as ISI, hybrid and OSI within the clinical sample. Occurrence and frequency of different responses was linked to both *type* of task and the *age* of participants. In the *ISI tasks*, the significantly poorer performance of the clinical sample stemmed from *higher non-compliance rates*, whereas rates of incorrect responses were similar and in some cases lower than in the TD sample.

Since non-compliance rates were lower, differences between the oldest TD and SLD groups were reduced or non-significant. Thus, it appears that once children in the SLD sample attempted to reproduce postures and gestures, they were as competent as TD peers. In contrast, differences between the TD and SLD samples in the *hybrid task* stemmed from higher percentages of *incorrect responses as well as non-compliance* in the two younger clinical groups. Thus, it appears that more children in the SLD sample *attempted* to reproduce pretend acts than postures and gestures, but reproduced these incorrectly. Closer inspection of children's incorrect errors revealed that although conventional and inaccurate responses occurred in both samples, children in the SLD sample were twice as likely to use an object in its conventional or instrumental way, rather than imitating the counterfunctional action. In the *OSI tasks*, levels of incorrect responses and non-compliance were very similar in the typical and clinical samples, manifesting in non-significant differences in all comparisons.

4.1.3 Relations between ISI and language in the clinical sample

Relations between performance on ISI, as an indicator of sociocognitive abilities, and receptive and expressive language were investigated in the clinical sample.

The majority of children in the **youngest group** *refused* the ISI tasks, and scored low on expressive language, but not on receptive. Half the participants presented with expressive, the other half with combined language profiles, and neither correlational analyses nor Fisher's Exact Test revealed significant relations between performance on ISI and language. This is contrary to the prediction that children with selective difficulty with ISI would have difficulty with understanding meaning intentions behind utterances that would result in difficulties with language, most notably receptive language.

In the **middle group**, more children attempted to reproduce the ISI tasks, though they still achieved lower scores than TD peers. Again, roughly half the participants had expressive, the other half combined language profiles. Fisher's Exact Test revealed no significant association between ISI and language profiles, but correlational analyses showed moderately significant relations between ISI and *expressive* language skills. In line with results of correlational analyses, closer inspections showed that children who did not replicate any posture or gesture were not credited with *any* correct expressive language item, irrespective of language *profile*. Thus, contrary to predictions, there appeared to be a relation between the *severity* of children's *expressive* language and ISI problems in this group.

All three language profiles occurred in the **oldest group**, and just one-third of participants had low ISI profiles and two-thirds typical. In line with the prediction that children with selective difficulty with ISI would have difficulty with discovering the meaning of language, correlational analyses revealed a moderately significant relation between ISI and *receptive* language skills, and closer inspection showed that participants who performed *most poorly* on ISI had the *most severe* receptive language deficits. While no significant associations between ISI and language profiles were found, close inspection of children's performance revealed interesting trends in relations between ISI and language profiles that are mostly in line with predictions of the mapping theory. Two of 3 children with expressive language profiles performed like TD peers on ISI, indicating no problems with social cognition, whereas the 2

children with receptive language profiles had difficulty with ISI, indicating sociocognitive constraints. Turning to children with combined language profiles, children with relatively mild receptive difficulty performed like TD peers on ISI, whereas children with severe receptive language difficulty performed poorly on ISI, and it was argued that *mild* receptive difficulties primarily reflect limitations in morphosyntax, whereas *severe* receptive difficulties primarily reflect sociocognitive difficulties. However, numbers were small and further investigation is needed to determine whether these relationships hold in a larger sample.

Overall, different relations between performance on ISI and language emerged at each age range, suggesting that the nature of associations between ISI and language might be linked to age and change over time. Although findings have to be interpreted with caution due to the small sample sizes, it seems to appear that results of the two younger groups were not in keeping with predictions, whereas there were some indications of predicted relations between ISI and language in the oldest group.

4.1.4 Verbal Imitation

As a subsidiary aim, this study compared the performance of TD and SLD groups on a range of verbal imitation tasks. As predicted, since groups were defined by typical versus delayed language development, significant differences between TD and SLD groups were found on all verbal imitation tasks. In contrast to the nonverbal imitation tasks, group differences were not linked to the type of task or the age of participants. Within the clinical sample, mean scores on the word-nonword task consistently increased with age, whereas mean scores on the sentence task remained low across age.

Relations between performance on ISI and verbal imitation were explored in the clinical sample, in terms of patterns of overall imitation responses and language profiles. It was found that the majority of participants with SLD either refused ISI *and* verbal imitation tasks or attempted both, but response changed with age from refusal in the youngest group to attempt in the oldest group. In contrast, mismatched response to ISI and verbal imitation was relatively rare. In line with above observations on relations between ISI and language, no meaningful associations between overall imitation responses and language profiles were found in the two younger SLD groups. In contrast, interesting trends in relations between 'overall imitation responses' and language profiles were observed in the oldest SLD group, pointing towards the possibility that participants in this group refused verbal imitation not only because of their difficulty with language, but also because of their difficulty with social cognition.

4.2 Nonverbal imitation skills in children with SLD

Implications of results for our understanding of nonverbal imitation skills and deficits in children with SLD are identified and discussed in this section.

4.2.1 ISI as indicator of social cognition

The SLD sample performed significantly below the TD sample on nonverbal imitation tasks categorised as ISI, whereas nonverbal imitation tasks categorised as OSI were no more challenging for children with SLD than TD children. Thus, it appeared that some children with SLD had difficulty with nonverbal imitation, but the nature of the task had a considerable effect on children's imitation performance. Accordingly, children with SLD did not show a *general* difficulty with nonverbal imitation, but a *specific* difficulty with measures of ISI. These findings are in line with the prediction that some children with SLD would have difficulty with measures of ISI, since the elicited reproduction of ISI behaviour is assumed to draw on children's sociocognitive abilities, and it was hypothesised that the clinical sample would include children with such deficits. They are also in keeping with the prediction that children with SLD would be as competent as TD peers to reproduce OSI behaviour, since the elicited reproduction of OSI behaviour is assumed to be relatively independent of sociocognitive capacities.

Previous research with children with atypical language development is mostly in line with results of this study: Dohmen (2007), Hill (1998), Marton (2009) and Vukovic et al. (2010) also found that groups of children with specific deficits in language performed significantly more poorly than TD groups on posture and/or gesture imitation tasks, i.e. on measures categorised as ISI in this study. However, contrary to outcomes of this study, Hill (1998) found no significant differences between the performance of SLI and TD groups on posture imitation, and a comparison of LI and TD groups on postures and gestures emerged as non-significant in Smith and Bryson's (1998) investigation. As discussed in section 1.3, Hill attributes the non-significant difference to ceiling effects, implying that the unexpected outcome might be influenced by the task design. In Smith and Bryson's study, LI and TD children were matched on receptive language skills. If these children were matched on receptive language it might be expected that they had sociocognitive skills of a similar level, which might account for the non-significant differences in performance between LI and TD groups on posture and gesture imitation. Accordingly, the non-significant difference might be interpreted as supportive of rather than contrary to the hypothesis that measures of ISI are indicative of social cognition.

No previous investigation has addressed the ability of children with atypical language development to reproduce outcome-sensitive targets.

WHY IS ISI IN CONTRAST TO OSI SO CHALLENGING?

What is it about ISI that makes it so challenging for children with sociocognitive difficulty while the ability to reproduce OSI is relatively spared? To address the question, differences between OSI and ISI have to be reconsidered.

Common instrumental acts, categorised as OSI in this study, are actions on objects resulting in salient instrumental effects. Outcomes of these functional tasks are observable and relatively unambiguous, especially in terms of objects with an inherent instrumental function that is intrinsically biased towards one possible outcome (e.g. turn the handle of a music box to evoke music). The main reason for children to reproduce such actions is to achieve an outcome rather than to engage in a social interaction. Thus, the child's reward is a functional and sensory effect rather than a social feedback. Accordingly, children's reactions are primarily guided by the physical *outcomes* of instrumental acts and less by the demonstrator's *intentions* behind actions. OSI is considered as an important learning tool for young children, with the primary function of acquiring new skills which help solving instrumental problems.

In contrast, the elicited imitation of body movements, categorised as ISI in this study, is a rather purposeless action, especially when presented outside a context of physical exercising (e.g. a yoga lesson). The main reason for children to reproduce such purposeless actions is to engage socially with the demonstrator and therefore to share an enjoyable and affectively infused fun experience of mutuality, connectedness and understanding. Thus, the child's reward is a social reward-based positive feedback. ISI is considered to facilitate children's abilities to establish and maintain social relations and communication by experiencing socio-emotional engagement and practicing social communicative strategies in interactions.

When comparing OSI and ISI it is crucial to differentiate between outcomes, as *physical* states that are observable, and intentions, as *mental* states that are only inferable. Gattis (2002) emphasises that physical outcomes of instrumental acts are often singular and unambiguous, whereas most human behaviours might be performed because of multiple intentions. Accordingly, mental states are ambiguous to the observer, although the degree of uncertainty about the demonstrator's intentions behind a particular action might vary. Since body movements do not result in observable, unambiguous and salient instrumental outcomes, the demonstrator's intention behind such action is not obvious to the observer, but has to be inferred. Thus, the need to infer the 'relevant' intention out of multiple possibilities might be one reason why ISI is more challenging than OSI for children with sociocognitive problems. Furthermore, the reproduction of body movements, at least up to a certain degree, *necessarily* requires socio-emotional engagement with the demonstrator. The child *has* to focus on the demonstrator as a *person*, since there is no possibility of focussing on an object, and the need to *infer* the demonstrator's intention behind her/his action requires a sense of connectedness between the observer and the demonstrator as basis for sharing mental and emotional states.

In line with this argumentation, it was most striking to observe in this investigation *how* difficult it was for many children with SLD to establish, or at least accept, a sense of connectedness with the demonstrator in the ISI tasks. Children who happily engaged in the instrumental acts tasks clearly and decidedly refused to engage in the interaction of observing and reproducing body movements. Rather than ignoring the demonstrator and her action in an indifferent, unmotivated, or bored manner, numerous children showed relatively strong reactions of dislike, not only refusing to *reproduce* the body movement, but refusing to further *engage* in an interaction with the demonstrator, e.g. by terminating eye contact, frowning and shaking the head, or moving away. These observations are supported by the finding that the significantly poorer performance of the clinical sample on the ISI tasks stemmed from higher non-compliance rates and not from incorrect responses, implying that once children in the SLD sample *attempted* to reproduce postures and gestures, they were as competent as TD peers. Thus, the ability to establish a sense of connectedness with, or to 'tune into and map onto' the demonstrator, appeared to be at the core of children's difficulty with ISI in the SLD sample. In contrast, the majority of children in the TD sample had no difficulty in *attempting* the reproduction of body movements. In keeping with this interpretation, Rogers et al. (2010) beautifully describe an imitation interaction as 'a reciprocal frame [that] has been set up in a call-response format, in which the adult's behaviour invites a child's response' (p. 82), and 'believe that children without autism feel this invitation and respond accordingly, reciprocally and imitatively'.

Mimicry shares important characteristics with the imitation of postures and facial expressions. It is the precise and synchronous copying of others' emotional and physical displays, a positive social feedback, with the function of establishing a form of mutual identification and empathy to enhance positive feelings between interaction partners (Byrne, 2005; Chartrand & Bargh, 1999). And indeed, in research with children with ASD, tasks requiring the reproduction of postures and facial expressions have in some cases been classified as mimicry tasks, and dysfunctions of the mirror neuron systems have been proposed as a root cause for difficulty with mimicry (Hamilton, 2008; Hamilton, Brindley, & Frith, 2007). However, although the imitation of body postures shares important features with mimicking emotional and physical displays, it differs in one essential aspect: imitation has been defined as a voluntary and volitional form of copying, whereas mimicry has been defined as an automatic, rapid and non-volitional form of copying (see section 1.1.1). Hence, ISI might be considered as the form of imitation that is most closely related to mimicry, but should not be equated with mimicry. This differentiation is in keeping with the observation that many children in the SLD sample clearly and decidedly refused to engage in the interaction of observing and reproducing body movements. Reconsidering Rogers et al.'s description of an imitation interaction as 'call-response format, in which the adult's behaviour invites a child's response', I believe that children with SLD very well *felt* this invitation, but that the response required specific sociocognitive skills that were difficult for some children, so these children did not like the invitation and *refused* it. In contrast, TD children not only accepted the invitation, but importantly *enjoyed* taking part in the call-response format.

HYBRID MEASURE: THE FUZZY BOUNDARY BETWEEN ISI AND OSI

Performance of children in the TD and SLD samples were compared not only on measures of ISI and OSI, but also on the imitation of pretend acts on substitute objects, a task on the cusp between serving an instrumental and social function that was categorised as hybrid between ISI and OSI. It was argued that the imitation of pretend acts on substitute objects draws on children's sociocognitive capacities, but that it is unclear whether these are necessary or merely helpful. In this study the task significantly differentiated performance of TD and SLD samples, but not as consistently across age groups and with smaller effect sizes compared with the ISI tasks. Thus, it appeared that some children with SLD had difficulty with the hybrid measure, supporting the hypothesis that pretend acts on substitute objects draw on sociocognitive capacities, and implying that the task is indicative of social cognition, though less dependent on sociocognitive skills than ISI, in line with the categorisation as hybrid.

Findings of previous research are mostly in line with results of this study: Dohmen (2007) and Thal and Bates (1988) also found that groups of children with language delay performed significantly more poorly than TD groups on the imitation of pretend acts with *substitute* objects, i.e. on measures categorised as hybrid. However, contrary to outcomes of this study, Smith and Bryson (2007) reported no significant differences between the performance of LI and TD groups on the same type of task. As reported above, LI and TD groups were matched on receptive language skills in this study, and it was argued that if these children were matched on receptive language it might be expected that they had sociocognitive skills of a similar level.

What is it about pretend acts that makes them more challenging than OSI for some children with SLD? Pretend acts on substitute objects might be characterised as odd actions with objects that create no singular and interesting effect. Accordingly, the correct reproduction of such acts requires the observer to focus on the *actions* of the demonstrator with an object, rather than the *outcome* of an action on an object. Further it is necessary to infer the demonstrator's specific intentions behind her/his actions on an object, since the object is not used in accordance with its common instrumental function. The analysis of errors was particularly informative about the nature of children's difficulty with the imitation of pretend acts on substitute objects: the task elicited lower rates of non-compliance and higher rates of incorrect response than the ISI measures, and children in the SLD sample were twice as likely to use an object in its conventional way, rather than to imitate the counterfunctional action. Thus, it seems that some children in the SLD sample shifted their focus from the demonstrator's actions with an object to the object and its conventional function. Accordingly, children's actions were guided by the inherent instrumental function of the object, rather than by the demonstrator's specific intention and goal behind her action. It is also interesting that children used the objects according to their instrumental function, although they did not observe the adult using them in this way. Hence, they responded to the affordance of the object instead of *imitating* the demonstrator. Since fewer children with SLD refused the hybrid compared to the ISI measures, shifting the focus from the demonstrator to the object seems to reduce difficulty in complying with an imitation task, possibly because it reduces the need to establish a sense of connectedness with the demonstrator. Thus, it might be argued that children interpreted a task with a primary social function as

task with a primary instrumental function, since they preferred to follow the affordance of the object rather than the invitation of the demonstrator to participate in an interaction.

Children's performance on pretend acts with substitute objects illustrates that not every form of imitation involving real objects can as a matter of course be categorised as OSI, and therefore as relatively independent of sociocognitive capacities, and that differences between ISI and OSI appear to be more subtle.

In line with this observation, children in the SLD sample did not respond as expected on the item 'touching dolphin'. Originally, this item was classified as a common instrumental act with a familiar object, and it was predicted that children with SLD would carry out this item effortlessly, since it was assumed to be relatively independent of sociocognitive capacities. Contrary to predictions, some children with SLD did not imitate the demonstrated action (i.e. stroking or tapping the dolphin), but performed a range of different actions that they associated with the soft toy (e.g. made the dolphin swim, showed the dolphin the room, threw the dolphin away). This raised the question what differentiated this particular item from others items classified as outcome-sensitive. Tapping and stroking a dolphin can be observed, but it does not result in a singular and salient outcome, since a soft toy has no inherent instrumental function that is biased towards one possible outcome. Accordingly, the action cannot be described as 'entirely' outcome-sensitive, but rather as functional play with a miniature soft toy that involves features of social communication and socio-emotional engagement. This implies that the reproduction of this action is not as independent of social cognition as originally assumed, and thus might be difficult for children with sociocognitive constraints. The connotations to emotional expressions towards the soft toy might furthermore be one reason why some children with SLD expressed dislike or rejection towards the dolphin.

Also in keeping with the argument that the distinction between ISI and OSI is not clear-cut, the literature review revealed that children with ASD, in comparison to TD peers, had difficulty imitating *arbitrary* instrumental acts on objects. It was argued that this difficulty was related to the fact that children have to *infer* the demonstrator's intention behind these odd actions on objects, since objects are not used according to children's previous experiences (e.g. turning on a light panel with the head instead of the hand). This implies that the imitation of arbitrary instrumental acts requires some sociocognitive capacities, although these actions involve real objects.

Others have emphasised that the instrumental salience of actions on objects varies from subtle, functional object affordance to strong sensory experience, and that the motivating effects of sensory feedback might influence the imitation performance of children (Ingersoll, Schreibman, & Tran, 2003; Rogers et al., 2010). Thus, the reproduction of instrumental acts resulting in salient sensory effects seems to provide the strongest functional reward and might therefore be the most attractive instrumental act.

Overall then, the findings in this study and wider evidence support the view that not every action that involves an object is outcome-sensitive, and furthermore that the difference between ISI and OSI is not clear-cut. Rather, the *specific* construction of an action on objects task seems to affect whether a task can primarily be categorised as OSI, and therefore as relatively independent of social cognition, or as hybrid

between outcome and intention-sensitive, and therefore as partially dependent on social cognition. Factors to be considered are whether objects have a singular inherent or multiple possible functions, whether the outcome of an instrumental action is a relatively subtle or a strong sensory experience, and whether an object is used in its conventional way, or in an 'odd' arbitrary, or counterfunctional way. In contrast, findings of this study showed that familiarity of objects did not influence children's performance on instrumental acts. 'Entirely' outcome-sensitive items can be reproduced correctly by focusing on the affordance of an object and its physical outcome even when these are novel, whereas the correct reproduction of hybrid items requires focusing on the demonstrator and her/his intentions behind actions. It appears that the more social and less instrumental the function of an action on an object, the more vulnerable it is. Thus, when interpreting children's performance on action on objects tasks it should be taken into account that such tasks vary in ways that make them more or less dependent on sociocognitive capacities and accordingly more or less indicative of social cognition.

4.2.2 Subtasks

No significant difference was found between performance of the TD and SLD groups on a subtask investigating whether children with SLD would have difficulty imitating unnecessary action details. Design and procedure were based on previous research in adolescents with ASD (Hobson & Hobson, 2008; Hobson & Lee, 1999), since authors reported significant differences in performance between groups of adolescents with ASD versus developmental delay. The most obvious explanation for the differing finding in this study is the substantially younger age of participants. Children in the TD and SLD samples scored relatively low on this subtask, and it is likely that the young children focused primarily on the outcomes of the instrumental acts and neglected the unnecessary action details, irrespective of language status. However, differing results might also be due to different participant groups. To determine whether age and/or group are key factors, it would be necessary to compare performance of age-matched SLD/SLI and ASD groups.

A second subtask followed up findings that TD children take a model's reasons for an action into account in interpreting the relevance of an observed behaviour (Schwier et al., 2006). Children with SLD in this study performed like the TD children on this task, with a preference for using the chimney instead of the door to enter a toy mouse into a toy house. It is most likely that children considered the chimney-route as much more enjoyable action than the door-route, irrespective of language status. Furthermore, toddlers might not have considered the action 'making a mouse enter a toy house through the chimney' as unusual, which might have triggered a search for the relevance of the observed behaviour, but rather as a commonly experienced everyday action, that requires no further consideration, especially when presented as part of a whole battery of imitation tasks.

4.2.3 Nonverbal imitation errors

A comparison of patterns of nonverbal imitation errors in the TD and SLD samples revealed that both types of errors, non-compliance and incorrect responses, occurred in both samples. Furthermore, the majority of incorrect responses occurring in the SLD sample resembled those in the TD sample, except elicited responses for the item 'touching dolphin' (see section 4.2.1) and some occasionally occurring unrelated errors. Thus, it appears that nonverbal imitation tasks designed for this study overall elicited the same types of errors in TD and SLD children rather than qualitatively different types.

This finding is in line with previous research investigating the nature and rate of nonverbal imitation errors in children with ASD (Beadle-Brown, 2004) and children with SLI (Hill et al., 1998; Marton, 2009): authors consistently found the same types of nonverbal imitation errors in typical and clinical samples, though there were differences in the frequency with which these occurred. Differences in frequencies were found between ASD/SLI and TD samples, but also within samples, since children within younger age ranges unsurprisingly produced more imitation errors than children within older age ranges. In keeping with previous research, the highest percentages of errors in this investigation were found in the youngest and the lowest in the oldest groups within the typical and clinical samples across tasks. Thus, results support the view that nonverbal imitation skills improve as TD children *and* children with SLD/SLI get older. The largest increase of scores in this study was found between the middle and oldest groups in the *clinical* sample on the posture, gesture and pretend act tasks, demonstrating that nonverbal imitation tasks hypothesised to be indicative of sociocognitive capacities appeared to be difficult for a much larger number of 2-year-old than 3-year-old children with SLD. By the oldest SLD group, types and rates of errors seem to resemble those in the youngest TD group. This error pattern suggests a delay rather than deviance in the elicited immediate imitation of postures, gestures and pretend acts in some children with SLD, a suggestion supported by empirical evidence of investigations reported above. However, numbers of participants were small and further investigation is needed to determine whether these patterns hold in a larger sample using a more fine-grained scoring system.

In analysing error patterns, selective non-compliance was considered as evidence of difficulty rather than uncooperativeness, and it was argued that the exclusion of non-responses would risk losing important information about children's nonverbal imitation performance. Results of this investigation support this view on non-compliance, since children in the SLD sample showed a pattern of selective non-compliance affecting those nonverbal imitation tasks that were predicted to be difficult for some children with SLD. Furthermore, different patterns of errors were associated with ISI, hybrid and OSI measures within the SLD sample which seem to reflect the specific nature of children's difficulty with different tasks. Refusal, associated with ISI, appears to reflect children's particular problems in establishing a sense of connectedness with the demonstrator as a person. In line with findings of this study, previous research comparing imitation performance in *preschool-age* TD and SLD/ASD groups also found higher non-compliance rates on ISI tasks in the ASD/SLD groups, but similar non-compliance rates on OSI tasks in all groups (Charman et al., 2003, 1997; Dohmen, 2007; Rogers et al., 2010). Thus, non-compliance with nonverbal imitation tasks seems to express difficulty with specific tasks or items rather than uncooperativeness.

However, given that the majority of 3- year-old children in the SLD sample performed like TD peers, why have *school-age* children with SLI been found to perform significantly below TD peers on posture and gesture imitation tasks in some studies (Hill et al., 1998; Marton, 2009; Vukovic et al., 2010)? Furthermore, why did children in Hill et al.'s investigation show a pattern of incorrect errors but produced very few non-responses? To address these questions, it has to be taken into account that the posture and gesture tasks in these studies were constructed for older children. Accordingly, tasks included motorically more demanding postures and gestures, and employed more differentiated and rigorous scoring criteria which would not be feasible for assessing toddlers. Thus, it might be that scoring criteria applied to older children reveal more subtle or fine grained differences between the performance of TD and SLI groups than those applied to younger children. However, it might also be speculated that preschool-age children show broader and less refined error patterns than school-age children which are not related to more rigorous scoring criteria, but to the fact that children's difficulty with posture and gesture imitation might manifest differently at different ages and thus change over time. Furthermore, reduced non-compliance rates in older children with SLI might be influenced by the fact that school-age children have had much longer exposure to social groups and institutions and therefore to social communicative rules and customs than toddlers, and may have learned that it is socially unacceptable to refuse participation in interactions, especially when demonstrated by an adult who might be associated with a teacher.

In summary, there are indications that error patterns, and especially non-compliance rates, are not only linked to specific imitation tasks, but also to specific age ranges, and it is possible that patterns of difficulty in nonverbal imitation in children with SLD/SLI change with age and maturation. However, since the majority of papers give no information on non-compliance and few studies have looked in depth at children's error patterns, these observations remain speculative.

4.2.4 Influence of motor skills and nonverbal IQ

A number of studies have demonstrated a close link, or co-morbidity, between SLI and poor motor skills (Hill, 2001). Since the reproduction of postures and gestures as well as the handling of objects requires basic motor and praxis skills, insufficient motor skills might influence children's imitation performance. To consider the possible impact of difficulties at the output or motor execution level on nonverbal imitation performance, participants' fine and gross motor skills were assessed using standardised subtests in this study. No evidence of differential motor performance which might have affected nonverbal imitation performance was found in the TD and SLD samples at any age range. Furthermore, error analyses revealed that the significantly poorer performance of the SLD sample in the posture and gesture tasks was due to higher non-compliance rates, implying that once children with SLD attempted to reproduce postures and gestures, they were as competent as TD peers.

These findings are in accordance with previous research reporting that the poor imitation performance of 18-32-months old children with SLD and 9-year-old children with SLI could not be explained by poor motor skills (Hill, 1998; Thal & Bates, 1988). However, findings are contrary to results of Marton (2009) and Vukovic et al. (2010), who reported significant differences between age-matched TD and SLD groups. Children were 4-7 years old and therefore older than children in this investigation, which might account for differences in outcomes. However, it is surprising that children in the SLI groups performed so poorly, since tests administered in both studies involved relatively basic motor items (e.g. balancing backwards, hopping, walking in a straight line; see section 1.3). Given that participants in these investigations were not assessed on standardised language tests, since there are no such tests available in Hungary and Serbia, it is possible that SLTs in Marton's and Vukovic et al.'s studies might have referred children who fulfilled slightly different selection criteria than children in Hill's study.

The question whether children with poor nonverbal imitation skills have primary difficulty with imitation or motor planning and execution has also been addressed in investigations with children with ASD. Studies using regression analyses and partial correlations to look in more depth at the impact of motor skills on imitation performance found that motor skills could not account for the variance in imitation performance between ASD and control groups (Rogers et al., 2003; Vivanti et al., 2008; Zachor et al., 2010). Overall then, it is possible that motor skills might contribute to poor nonverbal imitation skills in children with SLI, but it is unlikely that they fully account for the difference in nonverbal imitation ability between TD and SLI groups. Importantly, the differences observed in nonverbal imitation tasks in this study cannot be attributed to children's motor abilities.

To participate in this study, children had to satisfy the recruitment criteria of nonverbal cognitive development within typical limits. No concerns about children's cognitive development in the youngest typical and clinical groups were expressed by parents or health professionals and all children in the older typical and clinical groups scored within norms on the BAS II. Accordingly, a deficit in nonverbal IQ could be ruled out in interpretation of performance on nonverbal imitation tasks. However, it has to be considered whether the significant difference on nonverbal IQ between the oldest TD and SLD groups might have affected imitation performance. Given that children in the oldest SLD group performed

significantly better than children in the middle SLD group on ISI and pretend acts tasks, and furthermore that differences in nonverbal imitation performance between the oldest TD and SLD groups were weaker or non-significant compared to the middle groups, it is unlikely that the differences observed in nonverbal imitation were affected by the difference in nonverbal IQ.

4.3 Relations between ISI and language in children with SLD

Contrary to predictions, different relations between performance on ISI and language emerged at each age range. Implications of results for our understanding of different sources and trajectories of language deficits in children with SLD are identified and discussed separately for each age range in this section.

4.3.1 Age range 2;0-2;5 years

Contrary to predictions, no significant relations between performance on ISI and receptive and expressive language were found in the youngest SLD group. The limited diversity of patterns of language difficulty in this group might be one reason why relations between language and ISI appeared to be relatively uninformative. Reasons for this lack of diversity and implications for the use of measures of ISI will be considered.

Almost all children in this group performed very poorly on expressive language, demonstrated by floor effects on the subtest 'sentence production', whereas performance on receptive language was significantly better. Thus, it appears that language problems at this very young age surfaced in relatively similar, rather than differentiated and well-defined patterns of language difficulty. These could be characterised as broad patterns of language delay, rather than specific patterns of language impairment, and might reflect the different manifestation of language problems in toddlers with SLD in contrast to older children with SLI. However, the limited diversity of patterns of language difficulty could also be influenced by the fact that delayed expressive language is more likely to be noticed by parents and paediatricians than receptive language problems which are less salient if children are talking. Accordingly, it is possible that a disproportionate number of children with salient expressive language problems were referred to this study, resulting in a biased distribution of patterns of language difficulty at this age. Furthermore, it is well known that the early stages of language development are characterised by a substantial variation in onset and rate, and it has been found that a substantial number of children with SLD move into the typical range of language development when they get older (Ellis & Thal, 2008; Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994). Language performance of some children in the youngest group might therefore reflect the lower end of the typical range of language acquisition, rather than a clinically significant language delay indicative of persistent language impairment. Such children would be identified as 'late bloomers' in the follow-up study (see section 4.6.1). Since they would not fit criteria for language delay at the age of 3, they would not have been included in the oldest group in this study. One reason to think this may be the case is the observation that in this age group a higher percentage of mothers of children with SLD compared to mothers of TD children achieved a university degree (see section 2.3.7), and well-educated mothers are more aware of the typical developmental course of language and therefore particularly alert to their children's language.

Turning to ISI, children's patterns of performance appear to be as limited as to those observed for language: the majority of children scored poorly, resulting in similar profiles of low ISI performance. Considering possible reasons for this outcome, it is important to note that in the youngest TD group more than one third of ISI items elicited errors, with 2 participants refusing the ISI tasks, and the 'refusers' were the 2 youngest male participants in the typical sample (2;0 and 2;2 years). This raises the question when in typical development children begin to show ISI, and whether this point of acquisition might be around the age of 2;0-2;5 years. Surprisingly, it seems that the developmental course of ISI in TD children is not yet established and is subject to debate, since findings differ between studies (Gattis, 2002; Heyes & Ray, 2002; Jones, 2009). Nevertheless, some authors refer to the age of 18 months (Tomasello & Carpenter, 2005; Want & Harris, 2002) or the 'third quarter of the second year' (Jones, 2009) as the point when children typically begin to show intention-sensitive imitation. This age is indeed close to the chronological age of participants in the youngest group. Accordingly, low ISI profiles might in some cases reflect the lower end of the normal range, rather than clinically significant difficulty, as argued for language.

Hence, it appears that a number of children in the youngest group may be following a slow developmental course in terms of ISI *and* language, but with the potential to 'catch up' and be within the typical range for both skills within a year or two. This outcome implies that the clinical value of ISI measures as indicators of sociocognitive difficulty could be limited at the age of 2;0-2;5 years. The planned follow-up study will reveal whether a substantial number of children had delays in language and ISI that resolve by 4 years, and whether their early profiles are in any way informative about their subsequent development (see section 4.6.1).

4.3.2 Age range 2;6-2;11 years

As in the youngest group, children in the middle SLD group performed poorly on expressive language, and performance on receptive language was significantly better. However, children's language performance showed slightly more variability than in the youngest group: scores on expressive language, especially sentence production, were not at floor and were more widespread. Again, it is likely that some of these children are 'late bloomers' and will move into the typical range of language development when they get older (Ellis & Thal, 2008).

Turning to ISI, proportionately more children in the middle than in the youngest group attempted to reproduce some items of the ISI tasks, resulting in a lower percentage of low ISI profiles. This means that profiles of ISI at the age of 2;6-2;11 years have more potential to be informative than at the age of 2;0-2;5 years.

In contrast to the youngest group, significant relations between ISI and language skills were found, but contrary to predictions, significant correlations were between ISI and *expressive* language not between ISI and receptive language. However, no significant relations were found between ISI and language *profiles*. The reason for this different outcome is that performance on ISI was related to the *severity* of expressive language difficulty, and not whether children had receptive language difficulties or not, and the most striking characteristic of children's language in this age group was whether they were talking or not. Children who refused postures or gestures were not credited with any correct expressive vocabulary item, irrespective of their receptive language skills. In simple terms, those children who did not reproduce postures and gestures did not produce words.

Informal observation of toddlers' in their everyday life shows that some children spontaneously, extensively and enthusiastically imitate the language of their interlocutors within the short time frame prior and parallel to the onset of expressive vocabulary. It appears that they do this just for the sake and fun of reproducing and *using* expressive language in social communications, rather than for expressing specific meaning intentions with their utterances. Once children have acquired enough verbal language to communicate, they seem to stop this behaviour, except for occasional reproductions of particularly unusual or interesting and previously unknown words. In line with these informal observations, Nadel et al. (1999) and Nadel (2002) propose that immediate nonverbal imitation serves as preverbal imitative language which prepares communicative scripts for verbal language. Crucially, the authors report that imitative language emerges around 18 months, with a peak around 30 months and disappears when the child has acquired enough verbal language to communicate.

It may be speculated that the spontaneous imitation of words and utterances in toddlers' everyday life plays a particular role in the early acquisition of expressive language. When children start to produce language, words as a means to express intentions seem to be relatively fragile, but as words are used and practised in different social contexts, the discovery of forms, meanings and connections between forms and meanings becomes more elaborated, and their retrieval and production becomes more robust (Chiat, 2001; Gershkoff-Stowe, 2001, 2002). In this vein, imitation might be seen as serving to practise the use of words as preparation for the exclusively intentional use of language in every day conversations, and as an

important step in the mapping process. Once the acquisition of vocabulary is in full swing, the amount of immediate verbal imitation reduces. However, it seems that not all toddlers explicitly imitate the language of their interlocutors. Hence, verbal imitation is not deemed necessary or even sufficient to acquire expressive language, but it might nevertheless be helpful for some children at the point in development at which expressive language begins to emerge, and this may reflect a process that occurs also in other children but is not externalised.

Although elicited immediate imitation of postures and gestures clearly differs from spontaneous imitation of words, both forms of imitation involve the matching and reproduction of previously perceived behaviour. Thus, it is possible that the elicited imitation of postures and gestures taps this particular aspect of 'matching and reproducing', which might be one explanation for the significant association between children's performance on ISI and expressive language at the age of 2;6-2;11 years, and more specifically the association between 'not producing expressive language' and not responding to ISI.

In the follow-up study it will be of particular interest whether children with low ISI profiles are at greater risk for later language impairment than children with borderline or typical ISI profiles, and whether their profiles on ISI are more informative about the risk of language impairment than measures of language (see section 4.6.1).

4.3.3 Age range 3;0-3;5 years

In the oldest group, patterns of language difficulty were more variable and differentiated than in the younger groups and the majority of children in the oldest group performed like TD peers on ISI tasks. Performance on ISI measures appeared to relate to the nature of children's language deficits: a significant relation was found between ISI and receptive language skills, and participants who performed poorly on ISI had the most severe receptive language deficits. Furthermore, participants with exclusive receptive language deficits had low ISI scores, whereas 2 out of 3 participants with exclusive expressive language deficits had typical ISI scores. These findings are in line with the predictions of the mapping theory that children with difficulty with ISI, proposed as indicator of difficulty with social cognition, would have difficulty with discovering the meaning of language. However, no significant relations between ISI and language profiles were found, and contrary to predictions, not all children with combined receptive and expressive language profiles performed poorly on measures of ISI. Based on the assumption that different underlying processing difficulties can surface in similar looking characteristics of language deficits, it was argued that mild receptive difficulties related to typical ISI performance might arise primarily from limitations in morphosyntax, whereas severe receptive difficulties related to poor ISI performance might arise primarily from limitations in social cognition. In this case, performance on ISI will be informative about the *sources* of children's receptive language difficulties, with implications for their severity.

The identification of children with severe receptive language deficits is clinically important, since delayed comprehension has been proposed as potential marker of greater risk for language impairment (Ellis & Thal, 2008). Early identification of difficulties underlying delayed comprehension might help to refine clinical intervention to support these children. In the course of the planned follow-up study it will be of particular interest whether children who performed poorly on measures of ISI at the age of 3;0-3;5 years are at greater risk for later language impairment than children who performed like TD peers (see section 4.6.1).

4.4 Verbal imitation

As predicted, significant differences between TD and SLD samples were found on all verbal imitation tasks at all age ranges. Implications of results for our understanding of verbal imitation skills and deficits in children with SLD and as clinical tools for German-speaking children are identified and discussed in this section.

4.4.1 Response on nonverbal versus verbal imitation in the clinical sample

The finding that a substantial percentage of children refused the verbal imitation tasks raised the question whether children's performance on verbal imitation might not only reflect difficulty with language, but also putative sociocognitive constraints, and it was argued that verbal imitation shares characteristic features with intention-sensitive nonverbal imitation.

The majority of participants in the clinical sample responded in a similar way to both types of imitation, irrespective of whether the content was nonverbal or verbal. Thus, it appears that response to ISI was in line with response to verbal imitation: the majority of participants in the youngest group refused imitation, approximately as many participants refused as attempted imitation in the middle group, and the majority of participants in the oldest group attempted imitation. However, mismatched response to ISI and verbal imitation occurred, though it was relatively rare. The planned follow-up study will reveal whether later language outcome of children who refused versus attempted imitation at the age of 2;5-2;11 years will differ, and later language outcome of children who presented with mismatched responses to ISI and verbal imitation will be particularly interesting (see section 4.6.1).

Furthermore, relations between overall imitation responses and language profiles were explored. Again, it appeared that implications of relations between overall imitation responses and language were in line with implications of ISI and language profiles: no meaningful associations between overall imitation responses and language profiles were found in the two younger groups, but interesting trends in relations between overall imitation responses and language profiles were observed in the oldest group. These observations pointed towards the possibility that verbal imitation tasks might not only tap skills in processing structural aspects of language, but also sociocognitive capacities. To date, no study has compared response to nonverbal and verbal imitation and explored relations to language, and further and more in depth investigations are clearly necessary to evaluate the proposed hypothesis. However, preliminary results of this study highlighted the possibility that results on verbal imitation tasks might be influenced by sociocognitive capacities, which should be considered when interpreting results of verbal repetition used as clinical tools.

4.4.2 Verbal imitation tasks as clinical tools for German-speaking children

With the aim of evaluating the clinical practicability and significance of verbal imitation as assessment tool for young German-speaking children, both samples were tested on verbal imitation, using an adapted version of the ERB (Seeff-Gabriel et al., 2008). As predicted, performance on all verbal imitation tasks significantly differentiated German-speaking TD and SLD samples with large effect sizes. Furthermore, the design, materials and administration time of the adapted assessments were found to be feasible for children at all age ranges. Thus, word, nonword and sentence imitation tasks were suitable for assessing German-speaking children to identify SLD at all age ranges. This finding is particularly interesting in terms of the sentence imitation task, since elicited sentence imitation as a clinical tool has not previously been investigated with children as young as 2 years in English or other languages. Unsurprisingly, the imitation of sentences was found to be more demanding than the word and nonword imitation tasks for both samples. Thinking of generating new clinical tools, the addition of more challenging word and nonword items has to be considered, since some children in the older SLD groups achieved scores close to ceiling in these tasks. Further, more in depth analyses of children's reproduction of words, nonwords and sentences are necessary to evaluate whether tasks are clinically informative about children's individual phonological and morphosyntactic processing skills and deficits and in addition, whether tasks will add valuable information to results yielded by general language tests. Moreover, the planned follow-up study and other future research will reveal whether results of verbal imitation tasks might be predictive of German-speaking children's later language outcome (see section 4.6.1). Overall, the verbal imitation tasks were practicable with children aged 2;0-3;5 years and informative about their language status. Thus, these tasks have the potential to extend assessment tools for German-speaking children.

4.5 Limitations of the study

Some methodological limitations of this research are identified and discussed in this section.

4.5.1 Common instrumental acts with familiar objects task

Despite careful construction and piloting, some limitations in the design of the common instrumental acts with familiar objects tasks were identified:

- As previously discussed, children in the clinical sample did not respond as expected on the item 'touching dolphin', which led to the reconsideration of this item and the conclusion that it had been incorrectly classified. However, the nature of children's responses in the SLD sample turned out to be particularly informative about their difficulty with nonverbal imitation.

- Strictly speaking, the item 'greet dolphin' should not have been classified as a nonverbal item.

- Following methodology reported in previous research, the common instrumental acts with familiar objects tasks were further designed to measure children's ability to imitate various action details and to adapt their response to varied contexts (Subtasks 1 and 2). Thus, each item tested effects of two factors, i.e. the main task and the subtask. Preferably, items of the main task should have been presented once without and once with varied action details/contexts to most clearly determine effects of each factor.

- Unfortunately, many children in the typical and clinical samples had difficulty turning the handle of the music box effortlessly enough to realise the style of the movement (i.e. turning handle gently or forcefully). Thus, this item should have been replaced by a motorically less challenging one.

- Finally, it would have been interesting to include *arbitrary* instrumental acts tasks with familiar and unfamiliar objects in the imitation battery to evaluate whether children's imitation performance would have been influenced by this factor. However, children in this investigation were very young and accordingly assessment time and demands were limited.

These observations emphasise the importance of careful and precise design of actions on objects tasks, considering multiple factors which might affect children's imitation performance.

Furthermore, the performance of children in the TD and SLD samples in the common instrumental acts on familiar objects task was compared at both task and item level. The motivation for the item analysis was the observation during the administration of the imitation battery that a number of children in the SLD group had particular problems imitating the item 'touching dolphin'. Therefore it was decided to explore whether group differences were due to this specific item. No such observations were made in any other imitation task, and therefore performance of TD and SLD samples was only compared at task level. However, theoretically it is possible that item-level analysis would reveal that significant differences between TD and SLD samples in measures other than the common instrumental acts on objects task might also be due to one or more particular items.

4.5.2 Recruitment of participants

Criteria and procedure to recruit participants for this study were systematically planned and carefully realised, and a range of background assessments were administered to ensure the fulfilment of selection criteria and to record potentially influential characteristics of participants. However, since this investigation employed a cross-sectional design, it is possible that age groups differed in characteristics other than chronological age. Accordingly, differences in results for different age ranges might not exclusively reflect children's chronological age, but could also have been influenced by the following factors:

- Since there was no suitable standardised measure for children under 2;6 years, children's nonverbal cognitive development in the youngest group was checked through parental questionnaires and questioning of health professionals who had referred participants, whereas the BAS II (Elliott et al., 1996) was used to measure children's nonverbal cognitive abilities in the older groups. Furthermore, there was a significant difference on nonverbal IQ between the oldest TD and SLD groups. However, the influence of this difference should be negligible, since all children scored within norms. Thus, children in the oldest SLD group did not perform particularly poorly, but children in the TD group performed above average.

- Similarly, children at each age range were assessed on different measures of language, which might have influenced the distribution of language profiles. However, it should be considered that all language measures used were standardised language tests.

- Participants in the TD and SLD samples were drawn from the same range of different socio-economic backgrounds in different areas in Germany, in an attempt to match groups on these variables. However, contrary to expectation, there were differences in parental education for the younger and the oldest groups: more parents of TD than SLD children achieved university degrees in the younger groups, whereas more parents of SLD than TD children achieved university degrees in the oldest group. It is possible that referral patterns may have influenced recruitment despite sampling in the same geographical and socio-economic areas.

Moreover, since data were analysed separately for each age range, results in this thesis are based on small numbers of participants and accordingly have to be interpreted with caution, especially regarding relations between performance on ISI and language.

4.5.3 Statistical power of data

Since data were analysed separately for each age range, results in this thesis are based on small numbers of participants. In addition, the distribution of data was significantly influenced by a number of outliers and the occurrence of ceiling effects. This resulted in violations in the underlying assumptions of normality and homogeneity in most data-sets and non-parametric Mann-Whitney-U tests and Spearman's

rho correlations were used for significance testing. Therefore, results in this thesis are based on analyses with limited statistical power. Accordingly, they have to be interpreted with caution and the need for replicating the study with larger numbers of participants is emphasised, especially regarding relations between performance on ISI and language and null findings between TD and SLD samples in the instrumental acts on objects tasks. However, it should be considered that null findings were supported by small effect sizes in all cases.

4.6 Future research

The findings reported in this thesis opened up a number of issues and questions that require further investigation.

4.6.1 Follow-up study

Over recent decades there has been a lively interest in investigating later language outcome and predictors of language development in children with SLD. The majority of studies have followed up late talkers, seeking to determine how initial performance on expressive and/or receptive language predicts severity and pervasiveness of later language deficits. Collectively, results have confirmed that a considerable number of children 'at risk' recover whereas others experience persistent language impairments. However, although studies have identified potential factors as predictors of later language outcome, so far findings have not consistently identified any single factor as *particularly* informative about children's later language outcome (Desmarais et al., 2008; Everitt, 2009).

Therefore, a follow-up study is planned to investigate the predictive value and clinical significance of performance on nonverbal and verbal imitation tasks for later language and communication outcomes of children who were identified as SLD at the age of 2;0-3;5 years. It will be of particular interest:

- whether children identified with low ISI profiles are at greater risk of later language impairment than children who had borderline or typical ISI profiles, and whether performance on ISI might be a better predictor of later language outcome than performance on general language tests.

- whether children who refused ISI *and* verbal imitation tasks are at greater risk of later language impairment than children who attempted ISI *and* verbal imitation tasks, and how children identified with mismatched overall imitation profiles perform on language when they get older.

- whether children identified with low ISI profiles present with specific profiles of later language impairment characterised by combined receptive and expressive language difficulties or even PLI.

- whether performance on verbal imitation, especially sentence imitation, is predictive of German-speaking children's later language outcome.

The design of this study makes it possible to investigate whether the clinical significance and predictive value of children's performance on nonverbal and verbal imitation tasks changes across age ranges, and therefore whether and at which age a screening of children's nonverbal and/or verbal imitation skills might be most informative about children's later language skills and deficits, over and above general language tests. However, numbers of participants in this thesis and in the follow-up study are small, so the need for replicating the study with larger numbers of participants is emphasised.

4.6.2 Further research questions

INFLUENCE OF MOTOR SKILLS, NONVERBAL IQ AND SOCIO-ECONOMIC BACKGROUND

Consideration was given to the possibility that motor skills, nonverbal cognitive abilities and socio-economic background might have influenced participant's performance on nonverbal imitation. It was concluded that these skills might contribute to poor nonverbal imitation skills, but are not likely to account for the difference between TD and SLD groups. The impact of these skills on nonverbal imitation could be analysed in more depth, using regression analyses, which would reveal whether and to what extend each of these conditions contributed to poor nonverbal imitation skills.

DIFFERENT SOURCES OF RECEPTIVE LANGUAGE DIFFICULTY

In discussing relations between performance on ISI and language, it was argued that mild receptive language profiles in the context of typical ISI performance might arise primarily from limitations in morphosyntax, whereas severe receptive difficulties in the context of poor ISI performance might arise primarily from limitations in sociocognitive skills. As previously discussed, numbers were too small to substantiate this proposed distinction, and furthermore no independent measures of social cognition, social communication and semantics were used. Accordingly, further investigation with larger numbers of participants and independent measures of social cognition, social communication and semantics is needed to evaluate the proposed distinction.

VERBAL IMITATION TAPS DIFFICULTY WITH LANGUAGE AND SOCIAL COGNITION

Explorations of children's overall imitation responses and profiles of language generated the hypothesis that verbal imitation tasks might not only tap skills in processing of structural aspects of language, but also sociocognitive capacities. Further and more in depth investigations with larger numbers of participants and independent measures of sociocognitive abilities are necessary to validate this interpretation.

SPONTANEOUS IMITATION OF LANGUAGE

It was speculated that the spontaneous imitation of words and utterances might have a facilitating role in the transition period from preverbal to verbal communication in children's development, and that measures of ISI might tap this particular aspect of 'matching and reproducing' within a limited age range. This interpretation needs further consideration and investigation in a study with TD children and children with SLD that focuses on children's spontaneous imitation of words and utterances around the onset of expressive language, and in addition investigates performance on elicited imitation of postures and gestures.

VERBAL IMITATION AS CLINICAL TOOLS FOR GERMAN-SPEAKING CHILDREN

This study demonstrated that verbal imitation measures have potential as clinical tools for German-speaking children. However, before these assessments are made available to the clinical community, more in depth analyses of children's reproductions are necessary to evaluate whether tasks are clinically informative about children's phonological and morphosyntactic processing skills, and whether tasks will add value information to results yielded by general language tests. Furthermore, the verbal imitation tasks would ideally be standardised on a large and fully representative sample.

NONVERBAL IMITATION PERFORMANCE OF CHILDREN WITH ASD

It would be interesting to compare performance on nonverbal imitation of the TD and SLD groups investigated in this study with performance of a group of children with ASD, using the same battery of nonverbal imitation tasks generated for this study.

4.7 General summary and conclusion

No study has previously investigated a range of different types of nonverbal imitation and relations to language in children with SLD. The most significant findings of this research are summarised in relation to questions it set up to address.

- Is there a significant difference in nonverbal imitation performance between TD and SLD samples?

Groups with SLD performed significantly below TD groups on some, but importantly not all, nonverbal imitation tasks. Findings demonstrated that children with SLD did not have a general difficulty with nonverbal imitation, but a specific difficulty with intention-sensitive target acts hypothesised to be indicative of sociocognitive abilities. It appears that the closer a target act was related to mimicry, and thus to a social function, the more challenging was the reproduction for some children with SLD. In contrast, the closer a target act was related to common actions on an object resulting in an observable functional effect, and thus to an instrumental function, the less challenging was the reproduction. Patterns of errors seemed to reflect the specific nature of children's problems with different nonverbal imitation tasks. Refusal was associated with ISI, and it was argued that the ability to establish a sense of connectedness with the demonstrator is at the core of children's difficulty in the SLD sample.

- Do types and rates of nonverbal error patterns in the oldest SLD sample resemble those in the youngest TD sample?

The majority of nonverbal imitation errors occurring in the SLD sample resembled those in the TD sample rather than being qualitatively different, and nonverbal imitation skills seemed to emerge with age in TD children and children with SLD. However, the largest difference in frequency of errors was found between the middle and oldest SLD groups, indicating that more 2-3-year-old than 3-3;5-year-old children with SLD had difficulty with the imitation of intention-sensitive target acts. A comparison of types and rates of nonverbal imitation errors suggested that error patterns in the oldest SLD group seemed to resemble those in the youngest typical group across tasks, pointing towards a delay rather than deviance in the elicited imitation of body movements and pretend acts within the SLD sample.

- Is performance on ISI, as an indicator of sociocognitive abilities, related to performance on language within the SLD sample at each age range?

Contrary to predictions, different relations between performance on ISI and language emerged at each age range, suggesting that the nature of associations between ISI and language might be linked to age and change over time. In the youngest group, no significant relations between performance on ISI and language were found, and it seemed that a number of children in the youngest group had a slow developmental course within typical variability in terms of ISI and language. In the middle group, performance on ISI related to the *severity* of children's expressive language problems, rather than the specific nature of their language profiles. In the oldest group, it was found that participants who performed most poorly on ISI had the most severe receptive language deficits, and interesting trends in relations between ISI and language emerged. However, findings and observations have to be interpreted with caution due to the small sample size and the cross-sectional nature of the study.

- Is there a significant difference in verbal imitation performance between TD and SLD groups at different age ranges?

As predicted, significant differences between TD and SLD samples were found on all verbal imitation tasks at all age ranges. Thus, verbal imitation tasks have the potential to extend assessment tools for German-speaking children.

An exploration of children's performance on ISI and verbal imitation showed that the majority of participants responded in a similar way to both types of imitation, and pointed towards the possibility that participants refused verbal imitation not only because of difficulty with language, but also because of difficulty with social cognition.

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Appendix

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A Recruitment procedure

A.1 Ethics approval

CITY UNIVERSITY LONDON

School of Community and Health Sciences

Research Office
20 Bartholomew Close
London EC1A 7QN

Tel: +44 (0) 20 7040 5763
Fax: +44 (0) 20 7040 5409

www.city.ac.uk

Ref: PhD/08-09/05

08 September 2009

Dear Andrea

Re: Investigating the relationship between children's imitation skills and language development.

Thank you for forwarding amendments and clarifications regarding your project. These have now been reviewed **and approved** by the Chair of the School Research Ethics Committee.

Please find attached, details of the full indemnity cover for your study.

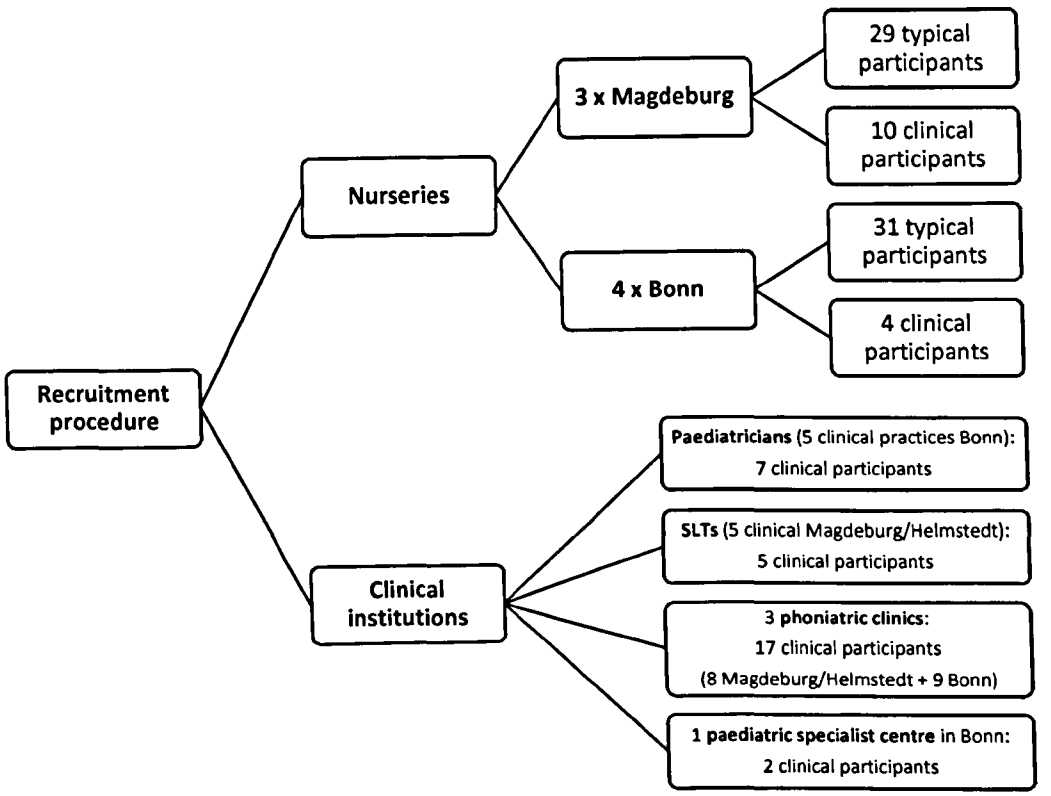
Under the School Research Governance guidelines you are requested to contact myself once the project has been completed, and may be asked to complete a brief progress report six months after registering the project with the School.

If you have any queries please do not hesitate to contact me as below.

Yours sincerely

Research Administrator

A.2 Breakdown of recruitment procedure



A.3 List of clinical institutions and nurseries

Phoniatric clinics

- Universitätsklinikum Magdeburg / Klinik für Hals-, Nasen- und Ohrenheilkunde
  Arbeitsbereich Phoniatrie und Audiologie
  Medizinische Fakultät
  Leipziger Straße 44
  39120 Magdeurg
  (Dr. med. Wilma Vorwerk)

- Universitätsklinikum Bonn / Klinik für Hals-, Nasen- und Ohrenheilkunde
  Abteilung für Phoniatrie und Pädaudiologie
  Sigmnd-Freud-Straße 25
  53105 Bonn
  (Prof. Dr. med. Götz Schade / Marie Nietfeld)

- Praxis für HNO und Phoniatrie
  Dr. med Ines Steinmayr
  Papenberg 26
  38350 Helmstedt

Paediatric specialist center

- Kinderneurologisches Zentrum Bonn (KiNZ)
  Gustav-Heinemann-Haus
  Waldenburger Ring 46
  53119 Bonn
  (Dr. med Hartmut Hollmann / Gabriele Keller)

Paediatricians (private practices)

- Praxis für Kinderheilkunde Dr. med. Martin Beck
  Neuer Markt 25
  53340 Meckenheim

- Praxis für Kinderheilkunde Dr. med. Hubert Radinger
  Poppelsdorfer Allee 26
  53115 Bonn

- Praxis für Kinderheilkunde Dr. med. Gunthild Kayser
  Kaiser Karl-Ring 1
  53111 Bonn

- Praxis für Kinderheilkunde Dr. med. Eva Killmann
  Obere Wilhelmstr. 31
  53225 Bonn

- Dr. med. Gabriele Ehmcke-Matthies
  Bundesstadt Bonn / Gesundheitsamt
  Engeltalstr. 6
  53103 Bonn

Speech and Language Therapists (private practices)

- Praxis für Logopädie Franka Stähle
  Max-Planck-Weg 1
  38350 Helmstedt

- Praxis für Logopädie Ines Wilhelm
  Ostendstraße 4
  39365 Eilsleben

- Praxis für Logopädie Irina Raabe
  Kreiskrankenhaus St. Marienberg
  Conringstraße 26
  38350 Helmstedt

- Praxis für Sprachtherapie Katrin Milkun
  Matthisonstraße 1
  39108 Magdeburg

- Praxis für Logopädie Anne Mietz
  Lannesdorfer Straße 2-4
  53179 Bonn

Nurseries

- Städtischer Kindergarten 'Zwergenland' (Lyngsbergschule)
  Lindstraße 14
  53177 Bonn
  (Leiterin: Frau Schuhmacher)

- Katholische Kindertagesstädte ‚St. Rochus'
  Fahrenheitstraße 5
  53125 Bonn
  (Leitung: Frau Mertens)

- Städtische Kindertagesstätte ‚Krümelkiste'
  Eduard-Otto-Straße 9
  53129 Bonn
  (Leiterin: Frau Enneking)

- Städtische Kindertagesstätte 'Am Stadion'
  Am Stadion 2
  53225 Bonn
  (Leiterin: Frau Krämer)

- Städtische Kindertagesstätte 'Im Metzental'
  Talstraße 7
  3177 Bonn
  (Leiterin: Frau Naß)

- Kindertagesstätten ‚Klettermax und Wundeland' (Stiftung evangelische Jugendhilfe St. Johannis Bernburg)
  Westernplan 30
  39108 Magdeburg
  (Leiterin: Frau Grimke)

- integrative Kindertagesstätte ‚Fliederhof I' (Independent Living – Kindertagesstätten Sachsen-Anhalt gGmbH)
  St. Josef Straße 17a
  39130 Magdeburg
  (Leiterin: Frau Winter)

A.4 Invitation letter clinical institutions

CITY UNIVERSITY
LONDON

Re: Investigating the relationship between children's imitation skills and language development

Dear Head of ...,

My name is Andrea Dohmen and I am a speech and language therapist with many years of experience, specialised in working with young children with language, speech and communication disorders. Currently I am studying towards a doctoral degree in Language and Communication Science at City University London (United Kingdom). My research is investigating relations between early imitation skills and language development in 2-3 year old typically developing and language delayed children. I would like to invite you and your institution to take part in this study.

During the first years of life children develop **non-linguistic and linguistic imitation skills**, including the imitation of novel actions on objects as well as the imitation of different kinds of gestures, sounds and words. These imitation skills are thought to be important for later language development and the relationship between imitation and language has been examined in typically developing children (Bates & Dick, 2002).

The **purpose** of my study is to investigate deficits in different nonverbal and verbal imitation skills as potential indicators of specific language impairment and further to analyse relations between patterns of imitation performance and profiles of language impairment. This knowledge would be an important foundation for developing diagnostic tools for early detection of language disorders. Furthermore it could enable us to work out intervention programmes to support these children.

All **assessments** are carried out in consultation with you and will be embedded into the regular diagnostic process within the scope of your aimed intervention. The tasks to assess the early imitation skills all have been designed specifically to keep young children engaged. The language assessments include routine tasks conducted with children in practices for speech and language therapy.

To **take part** in this study, children should meet the following criteria:

- aged between 24 and 42 months (2 – 3 ½ years)
- language delay/impairment
- normal motor development
- no known hearing loss, physical or neurological illness
- main language German

The project should be **carried out** in a quiet room at your practice. You, parents or another carer may attend the test sessions. I expect the tasks to be fun for the children involved. However, if any child is unhappy at any point in the session, I will stop the session immediately, and he or she will not be included in the study. The tasks are carried out normally in two to three sessions of 30-45 minutes each. To ensure reliable analysis, video recordings will be made of the children. Parents will be asked to answer a questionnaire about their child's general development and their home environment.

If you are willing to take part in my study I would ask you to help me select appropriate children and provide a room for the assessments. I would be as unobtrusive as possible in the practice setting.

All information which is collected about your practice and the children will be kept strictly confidential. The protocols and video tapes will be stored in a secure place and only my supervisors and I will have access to the **recorded data**. Any information about this study which is disseminated will have any personal identifiers removed so that you cannot be recognized from this. The collected data will be published anonymously within my dissertation and in any publications arising from this study.

If you would like any **further information** do not hesitate to contact me on andrea.dohmen.1@city.ac.uk. I also would like to contact you by telephone within the next 1-2 weeks to talk personally to you about my study.

Thank you for taking time to read this.

Yours sincerely,

Andrea Dohmen

Ethical Approval		
All proposals for research involving human participants are reviewed by an ethics committee before they can proceed. This proposal was reviewed and approved by the City University School of Community and Health Sciences Research Ethics Committee.The project does not involve any physically invasive or risky procedures. However, if there is an aspect of the study which concerns you, you may make a complaint and contact me, my supervisors or City University.		
Contact Details		
Chief Investigator: Andrea Dohmen, MSc andrea.dohmen.1@city.ac.uk You can also contact me personally during my time in the nursery.	Address: Department of Language and Communication Science City University Northampton Square London EC1V 0HB (UK) OR Institut für Germanistische Sprachwissenschaft Wilhelm-Röpke-Straße 6A D-35032 Marburg	Project Supervisors: Prof. Shula Chiat shula.chiat.1@city.ac.uk Dr. Penny Roy p.j.roy@city.ac.uk Prof. Christina Kauschke kauschke@staff.uni-marburg.de

A.5 Invitation letter nurseries

CITY UNIVERSITY LONDON

Re: Investigating the relationship between children's imitation skills and language development

Dear Head of Nursery,

My name is Andrea Dohmen and I am a speech and language therapist with many years of experience, specialised in working with young children with language, speech and communication disorders. Currently I am studying towards a doctoral degree in Language and Communication Science at City University London (United Kingdom). My research is investigating relations between early imitation skills and language development in 2-3 year old typically developing and language delayed children. I would like to invite you and your institution to take part in this study.

During the first years of life children demonstrate **non-linguistic and linguistic imitation skills**. This includes for example:

- to imitate how to use or what to do with novel objects in everyday situations,
- to imitate others facial and bodily gestures like pointing, waving good bye or nodding and
- to imitate perceived sounds and words while interacting with adults and children.

These nonverbal and verbal imitation skills are thought to be important for later language development. Therefore impairments of these abilities might be indicators of later language disorders. The **purpose** of this study is to find out more about the relationship between the development of early imitation skills and language development. This knowledge would be an important foundation for developing diagnostic tools for early detection of language disorders. Furthermore it could enable us to work out intervention programmes to support these children.

The **tasks** to assess the early imitation skills have all been designed specifically to keep young children engaged. In the assessment of actions on objects for example, I show the child a set of play-actions involving funny toys like squeezing a novel toy to produce a noise or building a tower with wooden blocks and ask the child to do like I do. In the assessment of gestures I carry out a set of bodily and facial movements involving everyday gestures like waving goodbye, pantomime gestures like drinking from a pretend cup or postures like lifting up both arms and then invite the child to perform the observed gesture. In the verbal imitation assessment I ask the child to repeat familiar and unfamiliar sounds and words which are embedded in a play context. In the language assessment tasks I will ask the child to point at pictures or name pictures.

To **take part** in this study, children should meet the following criteria:

- aged between 24 and 42 months (2 – 3 ½ years)
- normal motor development
- no known hearing loss, physical or neurological illness
- main language German

I would need to **carry out** the assessment sessions in a quiet room at your nursery. Parents or another carer may attend the test sessions. I will only include children who are happy to join in the session. We have found the tasks to be fun for the children involved, but if any child says or shows that s/he is unhappy at any point, I will stop the session and take them back to the nursery teacher. The tasks are typically carried out in two to three sessions of 30-45 minutes each. To check children's responses, the session will be videotaped with parents' permission. Parents will be asked to answer a questionnaire about their child's general and language development as well as their home environment.

If you are willing to take part in my study I would ask you to help me select appropriate children and provide a room for the assessments. I would be as unobtrusive as possible in the nursery setting and would work around regular activities such as circle time and meal breaks.

All information which is collected about your nursery and the children will be kept strictly confidential. The protocols and videotapes will be stored in a secure place and only my supervisors and I will have access to the **recorded data**. Any information about this study which is disseminated will have any personal identifiers removed so that you cannot be recognized from this. The collected data will be published anonymously within my dissertation and in any publications arising from this study.

If you would like any **further information** do not hesitate to contact me on andrea.dohmen.1@city.ac.uk. I also would like to contact you by telephone within the next 1-2 weeks to talk personally to you about my study.

Thank you for taking time to read this.

Yours sincerely,

Andrea Dohmen

Ethical Approval
All proposals for research involving human participants are reviewed by an ethics committee before they can proceed. This proposal was reviewed and approved by the City University School of Community and Health Sciences Research Ethics Committee.The project does not involve any physically invasive or risky procedures. However, if there is an aspect of the study which concerns you, you may make a complaint and contact me, my supervisors or City University.

Contact Details		
Chief Investigator: Andrea Dohmen, MSc andrea.dohmen.1@city.ac.uk You can also contact me personally during my time in the nursery.	Address: Department of Language and Communication Science City University Northampton Square London EC1V 0HB (UK) OR Institut für Germanistische Sprachwissenschaft Wilhelm-Röpke-Straße 6A D-35032 Marburg	Project Supervisors: Prof. Shula Chiat shula.chiat.1@city.ac.uk Dr. Penny Roy p.j.roy@city.ac.uk Prof. Christina Kauschke kauschke@staff.uni-marburg.de

A.6 Information sheet and consent form parents

CITY UNIVERSITY LONDON

INFORMATION FOR PARENTS

An invitation for your child to take part in a research project

Project Title: Investigating the relationship between children's imitation skills and language development

Personal information

My name is Andrea Dohmen and I am a speech and language therapist with many years of experience, specialised in working with young children with language, speech and communication disorders. Currently I am studying towards a doctoral degree in Language and Communication Science at City University London (United Kingdom). My research is investigating relations between early imitation skills and language development in 2-3 year old typically developing and language delayed children. I am inviting you and your child to take part in this study.

What is the purpose of this study?

During the first years of life children demonstrate imitation skills. This includes for example:

- to imitate how to use or what to do with novel objects in everyday situations,
- to imitate others facial and bodily gestures like pointing, waving good bye or nodding and
- to imitate perceived sounds and words while interacting with adults and children.

These nonverbal and verbal imitation skills are thought to be important for later language development. Therefore impairments of these abilities might be indicators of later language disorders. The purpose of this study is to find out more about the relationship between the development of early imitation skills and language development. This knowledge would be an important foundation for developing diagnostic tools for early detection of language disorders. Furthermore it could enable us to work out intervention programmes to support these children.

Who can take part in the study?

This study will include children who are:

- aged between 24 and 42 months (2 – 3 ½ years)
- normal motor development
- no known hearing loss, physical or neurological illness
- main language German

Where will the study take place?

The nursery/practice which your child attends has kindly agreed to support my study by offering the possibility to test children, whose parents agree to their participation and who are themselves willing to participate.

What does participation in the study mean for your child?

The project will be carried out in a quiet room of the nursery/practice. You or another carer may attend the test sessions. I will only include children who are happy to join in the session. We have found the tasks to be fun for the children involved, but if any child says or shows that s/he is unhappy at any point, I will stop the session and take them back to the nursery teacher/therapist.

The tasks to assess the early imitation skills all take the form of games. In the assessment of actions on objects for example, I show your child a set of play-actions involving funny toys like squeezing a novel toy to produce a noise or building a tower with wooden blocks and ask your child to do like I do. In the assessment of gestures I carry out a set of bodily and facial movements involving everyday gestures like waving goodbye, pantomime gestures like drinking from a pretend cup or postures like lifting up both arms and then invite your child to perform the observed gesture. In the verbal imitation assessment I ask your child to imitate familiar and unfamiliar sounds and words which are embedded in a play context. In the language assessment tasks I will ask your child to point at pictures or name pictures.

If your child regularly sees a speech and language therapist, all assessments will be embedded into the regular diagnostic process within the scope of your child's therapy and they are carried out in consultation with your speech and language therapist.

All tasks are carried out in two to three assessment sessions of 30-45 minutes each. To check children's responses, the session will be videotaped with your permission.

What will happen to the collected data?

All information which is collected about you and your child will be kept strictly confidential. The videotapes will be stored in a secure place and only my supervisors and I will have access to the recorded data. Any information about this study which is disseminated will have any personal identifiers removed so that you cannot be recognized from this. The collected data will be published anonymously within my dissertation and in any publications arising from this study.

What does participation in the study mean for you?

If you wish to take part, you should keep this information sheet but I would like to ask you to complete and sign the attached consent form as well as the questionnaire and to return both to the nursery teacher/therapist. The questionnaire is about your child's general development and about her/his early language development. I will then arrange to see your child in her/his nursery/practice. If there is a problem about language you will be informed. If you agree to your child taking part, you have the right to withdraw from this project at any time without giving reason.

If you have any further questions regarding my study or if you would like more information about it, please do not hesitate to contact me. Thank you for taking time to read this!

Yours sincerely,

Andrea Dohmen

Ethical Approval

All proposals for research involving human participants are reviewed by an ethics committee before they can proceed. This proposal was reviewed and approved by the City University School of Community and Health Sciences Research Ethics Committee.The project does not involve any physically invasive or risky procedures. However, if there is an aspect of the study which concerns you, you may make a complaint and contact me, my supervisors or City University.

Contact Details

Chief Investigator:	Address:	Project Supervisors:
Andrea Dohmen, MSc andrea.dohmen.1@city.ac.uk You can also contact me personally during my time in the nursery/practice.	Department of Language and Communication Science City University Northampton Square London EC1V 0HB (UK) **OR** Institut für Germanistische Sprachwissenschaft Wilhelm-Röpke-Straße 6A D-35032 Marburg	Prof. Shula Chiat shula.chiat.1@city.ac.uk Dr. Penny Roy p.j.roy@city.ac.uk Prof. Christina Kauschke kauschke@staff.uni-marburg.de

Complaints Procedure

City University has established a complaints procedure via the Secretary to the Research Ethics Committee.
To complain about the study, you need to phone +44 20 70403040. You can then ask to speak the Secretary of the Ethics Committee and inform them that the name of the project is:
Investigating the relationship between children's imitation skills and language development.

You could also write to the Secretary at:
Anna Ramberg
Secretary to Senate Ethical Committee
Research and International Development Office,
City University
Northampton Square, London EC1V OHB
Email: anna.ramberg.1@city.ac.uk

CITY UNIVERSITY LONDON

INFORMED CONSENT FORM FOR PARENTS/GUARDIANS OF PROJECT PARTICIPANTS

Project Title:

Investigating the relationship between children's imitation skills and language development

This study has been approved by the School of Community and Health Sciences Research Ethics Committee.

I agree that my child .....(full name of child) for whom I am a guardian may take part in the above City University research project. The project has been explained to me, and I have read the Explanatory Statement, which I may keep for my records.

I understand that agreeing to take part means that I am willing to allow Andrea Dohmen (Chief Investigator) to administer the imitation and language assessments to my child. I also agree to complete a questionnaire asking me about my child's general development and about her/his early language development.

I understand that any information I and my child provide is confidential. No identifiable personal data will be published. The identifiable data will not be shared with any other organisation.

I also understand that my child's participation is voluntary, that s/he can choose not to participate in part or all of the project, and that s/he or I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

	YES	NO
I give permission to video record the session with my child and to keep the recording until the end of the study.		
If my child has language problems this information can be forwarded to the nursery staff.		

Child's Name in Capitals: .....

Child's Date of Birth: .....

Parent's/Guardian's Signature: .....

Parent's/Guardian's Full Name in Capitals: .....

Signature of Parent/Guardian: .....Date: .....

Please turn over!

Please take a moment to fill in some information about your child.

	YES	NO
My child's main language is German.		
My child has or has had speech and/or language difficulties.		
My child has a known hearing loss.		
My child has developed typically (e.g. no diagnosed syndromes or specific illnesses).		

B Recruitment criteria

B.1 U-Untersuchungen

Listing of paediatric preventive screenings during childhood in Germany (*Kindervorsorgeuntersuchung* or *U-Untersuchungen*)

These preventive screenings are routinely carried out by paediatricians at specified ages during childhood, each focussing on different diagnostic targets related to children's developmental stages. They are voluntarily but highly recommended and costs must be covered by all public as well as private health insurers.

- U1 at birth
- U2 3.-10. day
- U3 4.-5. week
- U4 3.-4. month
- U5 6.-7. month
- U6 10.-12. month
- U7 21.-24. month
- U7a 34.-35. month
- U8 46.-48. month
- U9 60.-64. month
- U10 6-7 years
- U11 9-10 year

B.2 Parental questionnaire

B.2.1. German

NAME DES KINDES: _____

GESCHLECHT: Mädchen □ Junge □

GEBURTSDATUM: _____

HEUTIGES DATUM: _____

Um einen Einblick in die Gesamtentwicklung Ihres Kindes zu bekommen, möchte ich Sie bitten, diesen Fragebogen hinsichtlich der generellen und sprachlichen Entwicklung Ihres Kindes auszufüllen. Selbstverständlich werden diese Daten anonymisiert und streng vertraulich behandelt.

Bitte füllen Sie den Fragebogen möglich an einem Tag aus und geben Sie ihn im Anschluss in der Kindertagesstätte bzw. Praxis ab.

Herzlichen Dank für Ihre Mithilfe!

Dürfen wir Sie in Zukunft nochmals kontaktieren? Ja □ Nein □

ZUSÄTZLICHE ANGABEN / INFORMATIONEN (bei Bedarf):

_____

_____

_____

GESAMTENTWICKLUNG

Ist Ihr Kind eine Frühgeburt (vor der 37. Woche geboren)? Ja ☐ Nein ☐
Ist Ihr Kind ein Zwilling? Ja ☐ Nein ☐

Gab es seit der Geburt Ihres Kindes medizinische Probleme? Ja ☐ Nein ☐
Gab es jemals Auffälligkeiten bei den U-Untersuchungen? Ja ☐ Nein ☐

Wenn ja, welche? _____

Hat Ihr Kind jemals eine spezifische Förderung erhalten
(z.B. Frühförderung, Ergotherapie, Krankengymnastik)? Ja ☐ Nein ☐

Wenn ja, welche? _____

Hat Ihr Kind schon einmal unter einer Ohrenentzündung gelitten? Ja ☐ Nein ☐
Wenn ja, wie oft? 1-2mal ☐ 3-5mal ☐ häufiger ☐

Wann wurde der letzte Hörtest durchgeführt? _____
War dieser unauffällig? Ja ☐ Nein ☐

SPRACHENTWICKLUNG

Wann hat Ihr Kind das erste Wort / die ersten Wörter gesprochen (z.B. Auto)?
bis zum 15. Monat ☐ bis zum 18. Monat ☐ bis zum 24. Monat ☐ später ☐
Wenn Ihr Kind zwei- oder mehrsprachig aufwächst, was ist die andere Sprache (oder sind die anderen Sprachen)? _____
Ist Deutsch die überwiegend oder gleichwertig benutzte Sprache? Ja ☐ Nein ☐

Hat Ihr Kind jemals Sprachtherapie erhalten? Ja ☐ Nein ☐

Wenn ja, wie viele Therapiestunden wurden durchgeführt (ca.)? _____
Erhält Ihr Kind zur Zeit Sprachtherapie? Ja ☐ Nein ☐

Wenn ja, in welcher Praxis / Institution? _____

KINDERTAGESSTÄTTE / TAGESMUTTER

Besucht Ihr Kind eine Kindertagesstätte / Tagesmutter? Ja ☐ Nein ☐

Wenn ja, seit wann? _____

FAMILIE

Hatte bzw. hat ein Familienmitglied Sprach- oder Sprechprobleme? Ja ☐ Nein ☐

Wenn ja, wer? _____

Welchen Bildungsabschluss haben Sie? (Mehrfachnennungen möglich)

Mutter des Kindes oder die weibliche Bezugsperson des Kindes, die mit im Haushalt lebt

Hauptschulabschluss	☐	Berufsausbildung	☐
Realschulabschluss	☐	Fach- / Hochschulabschluss	☐
Fach- / Abitur	☐	Keine Ausbildung	☐

Vater des Kindes oder die männliche Bezugsperson des Kindes, die mit im Haushalt lebt

Hauptschulabschluss	☐	Berufsausbildung	☐
Realschulabschluss	☐	Fach- / Hochschulabschluss	☐
Fach- / Abitur	☐	Keine Ausbildung	☐

B.2.2. English

NAME OF YOUR CHILD: _____

GENDER: girl ☐ boy ☐

DATE OF BIRTH: _____

TODAY'S DATE: _____

Studies require additional background information about the participants. The purpose is to describe more precisely the people who are tested and to take different influencing factors into account. Hence, I would like to ask you to answer the following questions. All information will be treated confidentially and will be published anonymously! If you have any questions regarding these questionnaires or my study or if you like to get more information about it, contact me at Andrea.Dohmen.1@city.ac.uk.

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE!

Would you be happy for us to contact you again in the future? Yes ☐ No ☐

ANY INFORMATION YOU WOULD LIKE TO ADD:

_____

_____

_____

GENERAL DEVELOPMENT

Has your child been prematurely born (prior to the 37. week)? Yes ☐ No ☐
Is your child a twin? Yes ☐ No ☐

Did your child have any major health or medical problems? Yes ☐ No ☐
Where your paediatrician ever concerned about your child's development (U-Untersuchungen)? Yes ☐ No ☐

If yes, why? _____

Did your child ever receive a specific intervention (e.g. early intervention, occupational therapy, physiotherapy)? Yes ☐ No ☐

If yes, which? _____

Did your child ever suffer from an ear infection/glue ear? Yes ☐ No ☐
If yes, how often? 1-2x ☐ 3-5x ☐ more often ☐

When has your child's hearing been checked lastly? _____
Where there any concerns? Yes ☐ No ☐

Language Development

When did your child speak her/his first word (e.g. car)?
until the 15. month ☐ until the 18. moth ☐ until the 24. month ☐ later ☐
If German is not your child's only language, what is/are the other language(s)?

_____

Is German your child's main language? Yes ☐ No ☐

Did your child ever receive speech or language therapy? Yes ☐ No ☐

If yes, how many sessions did your child had? _____
Does your child receive speech or language therapy at the moment? Yes ☐ No ☐

If yes, in which institution? _____

NURSERY / CHILDMINDER

Does your child attend a nursery / childminder? Yes ☐ No ☐

If yes, since when? _____

FAMILY

Does any member of your family has a history of speech or language difficulties? Yes ☐ No ☐

If yes, who? _____

What is your educational achievement? (please tick appropriate)

Mother or female carer living in the household only

Secondary general school	☐	Vocational training	☐
Intermediate secondary school	☐	University degree	☐
Grammar school (A-level)	☐	No professional training	☐

Father or male carer living in the household only

Secondary general school	☐	Vocational training	☐
Intermediate secondary school	☐	University degree	☐
Grammar school (A-level)	☐	No professional training	☐

B.3 M-CHAT

B.3.1. German

Bitte, beantworten Sie die folgenden Fragen in Bezug auf das Verhalten Ihres Kindes mit JA oder NEIN, indem Sie die entsprechenden Kästchen ankreuzen. Versuchen Sie bitte, alle Fragen zu beantworten. Denken Sie dabei daran, wie sich Ihr Kind **normalerweise** verhält. Wenn das erfragte Verhalten nur selten aufgetreten ist (Sie haben es vielleicht ein oder zweimal erlebt), dann beantworten Sie die Frage bitte mit NEIN.

Name des Kindes:_____ Alter des Kindes:_____ Datum heute:_____

	JA	NEIN
1. Hat Ihr Kind Freude daran, wenn Sie es hin- und herschaukeln oder, wenn Sie es auf den Knien reiten lassen, etc.?	•	•
2. Zeigt Ihr Kind Interesse an anderen Kindern?	•	•
3. Klettert Ihr Kind gerne, zum Beispiel auf Treppen?	•	•
4. Spielt Ihr Kind gerne das „Guck-Guck-Spiel" oder Verstecken?	•	•
5. Hat Ihr Kind jemals so getan, als ob es sich beispielsweise mit einer Spielzeug-Teekanne Tee einschenken würde, oder hat es jemals ein anderes (imaginäres) Spiel gespielt?	•	•
6. Hat Ihr Kind jemals den Zeigefinger benutzt, um etwas zu zeigen oder um um etwas zu bitten?	•	•
7. Hat Ihr Kind jemals den Zeigefinger benutzt, um auf etwas zu zeigen oder um Interesse für etwas zu bekunden?	•	•
8. Kann Ihr Kind mit kleinem Spielzeug (z.B. Autos, Bauklötzen) richtig spielen, ohne es nur in den Mund zu nehmen, daran herumzufingern oder es herunterfallen zu lassen?	•	•
9. Bringt Ihr Kind Ihnen jemals Dinge, um Ihnen etwas zu zeigen?	•	•
10. Schaut Ihnen Ihr Kind länger als nur ein oder zwei Sekunden in die Augen?	•	•
11. Erscheint Ihr Kind jemals übermäßig sensibel gegenüber Lärm oder Geräuschen? (hält sich z.B. die Ohren zu)	•	•
12. Reagiert Ihr Kind mit Lächeln, wenn Sie es anschauen oder anlächeln?	•	•
13. Imitiert Sie Ihr Kind? (z.B. wenn Sie eine Grimasse schneiden)	•	•
14. Reagiert Ihr Kind auf seinen Namen, wenn Sie es rufen?	•	•
15. Wenn Sie auf ein Spielzeug am anderen Ende des Zimmers zeigen, schaut Ihr Kind es dann an?	•	•
16. Kann Ihr Kind laufen?	•	•
17. Schaut Ihr Kind Dinge an, die Sie gerade anschauen?	•	•
18. Macht Ihr Kind ungewöhnliche Fingerbewegungen nah an seinem Gesicht?	•	•
19. Versucht Ihr Kind zu erreichen, dass Sie seinen Handlungen Aufmerksamkeit schenken?	•	•
20. Haben Sie sich jemals gefragt, ob Ihr Kind gehörlos sein könnte?	•	•
21. Versteht Ihr Kind, was Leute sagen?	•	•
22. Starrt Ihr Kind manchmal ins Leere oder läuft ziellos herum?	•	•
23. Schaut Ihnen Ihr Kind ins Gesicht, um Ihre Reaktion zu überprüfen, wenn es etwas nicht Vertrautem begegnet?	•	•

Deutschsprachige Adaptation von Sven Bölte (2005)

The Modified Checklist for Autism in Toddlers

Hintergrund und Entwicklung. Diese Skala ist ein 23 binäre Items umfassender Elternfragebogen zur Früherkennung von Autismus-Spektrum-Störungen im Alter von 24 Monaten. Die M-CHAT (Robins et al., 2001) stellt eine Erweiterung und Modifikation der klassischen CHAT von Baron-Cohen et al. (1992) dar. Die ersten neun Items der M-CHAT wurden direkt aus der CHAT übernommen. Mit der M-CHAT wird versucht, diverse Schwächen der CHAT zu verringern. Das ist vor allem die geringe Sensitivität der CHAT. Baird et al. (2000) mussten bei einer Follow-up-Studie feststellen, dass die Sensitivität der CHAT für verschiedene Störungen des autistischen Spektrums nur zwischen 11.7 % und 38 % liegt, wobei die Spezifität mit über 97.5 % durchweg hoch war. Zudem ist es für einen Screener im engeren Sinne eher ungünstig, wenn – wie im Falle der CHAT – ein Experte zur Durchführung benötigt wird. Schließlich kann ein Screeningzeitpunkt von 18 Monaten wie bei der CHAT a priori vermehrt dazu führen, dass regressiver Autismus, der in der Regel erst zwischen dem 18. und 24. Lebensmonat auftritt, nicht identifiziert wird.

Ausgehend Videostudien an Kleinkindern, die später als autistisch diagnostiziert wurden (z.B. Osterling & Dawson, 1994), wurden im M-CHAT den neun Elternfragen des CHAT 14 weitere Fragen hinzugefügt.

Empirische Ergebnisse zur M-CHAT. In der Eichstichprobe lag die interne Konsistenz der M-CHAT bei Alpha = .85. Insgesamt wurden in der Erststudie N = 1.293 Kinder zwischen 16 und 30 Monaten eingeschlossen, die bei U-Untersuchungen in Pädiatrien rekrutiert wurden und Störungen der Entwicklung aufwiesen. Nach Screening (Stufe I) und weiteren Untersuchungsschritten (Telefoninterview (II), spezifische klinische Diagnostik (III) erhielten n = 39 Kinder eine Diagnose aus dem autistischen Spektrum.

Der Mittelwert im M-CHAT derjenigen Kinder, die letztlich eine Diagnose aus dem autistischen Spektrum erhielten, lag bei 10.3. Sechs Items zeigten eine hohe diskriminative Kraft bei der Trennung von betroffenen und nicht betroffenen Kindern (in absteigender Reihenfolge): 7, 14, 2, 9, 15 und 13. Die Diskriminanzfunktion ergab eine Sensitivität von 87 % bei einer Spezifität von 99 %. In der Gesamtstichprobe hatten eine beliebige Kombination von drei auffälligen M-CHAT-Items eine Sensitivität von 97 % bei einer Spezifität von 95 %. Eine Kombination von zwei auffälligen, hoch diskriminativen Items ergab eine Sensitivität von 95 % bei einer Spezifität von 99 %. Inzwischen wurden im Rahmen der M-CHAT-Evaluation N = 4.200 Kinder in Stufe I untersucht und die früheren Ergebnisse weitgehend repliziert (Dumont-Mathieu & Fein, 2005). Wong et al. (2004) publizierten Daten zur Chinesischen Fassung der M-CHAT und berichten vergleichbare psychometrische Eigenschaften. In ihrer Stu-die zeigten u. a. sechs beliebige auffällige M-CHAT-Items eine Sensitivität von 84 % bei einer Spezifität von 85 %. Für die vorliegende deutschsprachige Adaptation liegen noch keine eigenständigen empirischen Ergebnisse vor. Eine Studie zur Prüfung der Eigenschaften der M-CHAT in einer deutschen Population ist in Vorbereitung. Aufgrund der guten Vergleichbarkeit der Daten zur US- und chinesischen Fassung sowie Erfahrungen zur spanischen, japanischen und türkischen Fassung kann jedoch vorläufig

eine ausreichende interkulturelle Validität der M-CHAT auch für den deutschen Sprachraum angenommen werden.

Auswertung und Empfehlungen für die Anwendung und Interpretation. Die Evaluation der M-CHAT ist noch nicht vollständig abgeschlossen, da erst wenige zum Screening-Zeitpunkt auffällige Kleinkinder im späteren Kindesalter nachuntersucht wurden. Die bisher verfügbaren Daten weisen jedoch auf eine gute Stabilität früher Diagnostik hin, replizieren (Dumont-Mathieu & Fein, 2005).

19 Items der M-CHAT sind so gepolt, dass NEIN-Antworten einen Punkt ergeben, d. h. auffälliges Verhalten anzeigen (1 bis10, 12 bis 17, 19, 21, 23. Bei den anderen vier Items (11, 18, 20, 22) indiziert eine JA-Antwort einen Punkt. Zur Auswertung summieren Sie die auffällig beantworteten Items. Folgt man den Ergebnissen von Robins et al. (1999), dann weisen folgende Ergebnisse eine hohe Wahrscheinlichkeit für das Vorliegen einer Störung des autistischen Spektrums und keiner anderen Störungen im Alter von 16 bis 30 Monaten hin (empfohlen wird ein Screening mit der M-CHAT im Alter von 24 Monaten):

Gesamtwert = 3 (hohe Wahrscheinlichkeit)
Gesamtwert = 6 (sehr hohe Wahrscheinlichkeit)
[Erwartungswert bei einer Autismus Spektrum Störung = 10]

Mindestens zwei auffällige Antworten bei den folgenden Items (hohe Wahrscheinlichkeit):

2. Zeigt Ihr Kind Interesse an anderen Kindern?
7. Hat Ihr Kind jemals den Zeigefinger benutzt, um auf etwas zu zeigen oder um Interesse für etwas zu bekunden?
9. Bringt Ihr Kind Ihnen Dinge, um sie Ihnen zu zeigen?
13. Imitiert Sie Ihr Kind? (z. B. wenn Sie eine Grimasse schneiden)
14. Reagiert Ihr Kind auf seinen Namen, wenn Sie es rufen
15. Wenn Sie auf ein Spielzeug am anderen Ende des Zimmers zeigen, schaut Ihr Kind es dann an?

Literatur

Baron-Cohen, S., Allen, J. & Gillberg, C. (1992). Can autism be detected at 18 months? The needle, the haystack, and the CHAT. *British Journal of Psychiatry, 161*, 839-843.

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Wong, V., Hui, L.H., Lee, W.C., Leung, L.S., Ho, P.K., Lau, W.L., Fung, C.W. & Chung, B. (2004). A modified screening tool for autism (Checklist for Autism in Toddlers [CHAT-23]) for Chinese children. *Pediatrics, 114*, 166-176.

B.3.2. English

Instructions and *Permissions for Use of the* M-CHAT[a]

The Modified Checklist for Autism in Toddlers (M-CHAT; Robins, Fein, & Barton, 1999) is available for free download for clinical, research, and educational purposes. There are two authorized websites: the M-CHAT and supplemental materials can be downloaded from www.firstsigns.org or from Dr. Robins' website, at http://www.mchatscreen.com

Users should be aware that the M-CHAT continues to be studied, and may be revised in the future. Any revisions will be posted to the two websites noted above.

Furthermore, the M-CHAT is a copyrighted instrument, and use of the M-CHAT must follow these guidelines:

(1) Reprints/reproductions of the M-CHAT must include the copyright at the bottom (1999 Robins, Fein, & Barton). No modifications can be made to items or instructions without permission from the authors.
(2) The M-CHAT must be used in its entirety. There is no evidence that using a subset of items will be valid.
(3) Parties interested in reproducing the M-CHAT in print (e.g., a book or journal article) or electronically (e.g., as part of digital medical records or software packages) must contact Diana Robins to request permission (drobins@gsu.edu).

Instructions for Use

The M-CHAT is validated for screening toddlers between 16 and 30 months of age, to assess risk for autism spectrum disorders (ASD). The M-CHAT can be administered and scored as part of a well-child check-up, and also can be used by specialists or other professionals to assess risk for ASD. The primary goal of the M-CHAT was to maximize sensitivity, meaning to detect as many cases of ASD as possible. Therefore, there is a high false positive rate, meaning that not all children who score at risk for ASD will be diagnosed with ASD. To address this, we have developed a structured follow-up interview for use in conjunction with the M-CHAT; it is available at the two websites listed above. Users should be aware that even with the follow-up questions, a significant number of the children who fail the M-CHAT will not be diagnosed with an ASD; however, these children are at risk for other developmental disorders or delays, and therefore, evaluation is warranted for any child who fails the screening.

The M-CHAT can be scored in less than two minutes. Scoring instructions can be downloaded from http://www.mchatscreen.com or www.firstsigns.org. We also have developed a scoring template, which is available on these websites; when printed on an overhead transparency and laid over the completed M-CHAT, it facilitates scoring. Please note that minor differences in printers may cause your scoring template not to line up exactly with the printed M-CHAT.

Children who fail 3 or more items total or 2 or more critical items (particularly if these scores remain elevated after the follow-up interview) should be referred for diagnostic evaluation by a specialist trained to evaluate ASD in very young children. In addition, children for whom there are physician, parent, or other professional's concerns about ASD should be referred for evaluation, given that it is unlikely for any screening instrument to have 100% sensitivity.

Please fill out the following about how your child usually is. Please try to answer every question. If the behavior is rare (e.g., you've seen it once or twice), please answer as if the child does not do it.

1.	Does your child enjoy being swung, bounced on your knee, etc.?	Yes	No
2.	Does your child take an interest in other children?	Yes	No
3.	Does your child like climbing on things, such as up stairs?	Yes	No
4.	Does your child enjoy playing peek-a-boo/hide-and-seek?	Yes	No
5.	Does your child ever pretend, for example, to talk on the phone or take care of a doll or pretend other things?	Yes	No
6.	Does your child ever use his/her index finger to point, to ask for something?	Yes	No
7.	Does your child ever use his/her index finger to point, to indicate interest in something?	Yes	No
8.	Can your child play properly with small toys (e.g. cars or blocks) without just mouthing, fiddling, or dropping them?	Yes	No
9.	Does your child ever bring objects over to you (parent) to show you something?	Yes	No
10.	Does your child look you in the eye for more than a second or two?	Yes	No
11.	Does your child ever seem oversensitive to noise? (e.g., plugging ears)	Yes	No
12.	Does your child smile in response to your face or your smile?	Yes	No
13.	Does your child imitate you? (e.g., you make a face-will your child imitate it?)	Yes	No
14.	Does your child respond to his/her name when you call?	Yes	No
15.	If you point at a toy across the room, does your child look at it?	Yes	No
16.	Does your child walk?	Yes	No
17.	Does your child look at things you are looking at?	Yes	No
18.	Does your child make unusual finger movements near his/her face?	Yes	No
19.	Does your child try to attract your attention to his/her own activity?	Yes	No
20.	Have you ever wondered if your child is deaf?	Yes	No
21.	Does your child understand what people say?	Yes	No
22.	Does your child sometimes stare at nothing or wander with no purpose?	Yes	No
23.	Does your child look at your face to check your reaction when faced with something unfamiliar?	Yes	No

C Imitation battery

C.1 Data sheet version A

DATA SHEET VERSION A

code: date of birth: assessment date:

range: age: gender:

Mouse-house (Version A)						
	Outcome achieved	Detail accurate	Detail Incorrect	Detail not considered	Comments	2nd trial
Door closed	in house				**chimney** **door**	
Mouse **hops** (with house)	in house	hops				
Mouse **rising** intonation *hui* (**hops** to house)	in house	rising intonation				
Door open	in house				**chimney** **door**	
Mouse **hops** (without house)	movement	hops				

Postures and Gestures (BLOCK 1)						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Practice trial: Raise both arms straight above head						
Pat top of head with one hand						
Waving for greeting						
Lift one finger						
Pretend to **sleep**						
Touch shoulder						
Finger to lips for quiet						
Open and close mouth		----------				
Pretend to **eat with spoon**						
Form **T-sign** with hands						
Pull one ear						
Angry face		----------				

Present game (Version A)						
	Outcome achieved	Detail Accurate	Detail Incorrect	Detail not considered	Comments	2nd trial
Xylophone **forcefully**	Music					
Police-car **finger**	Car moves					
Dolphin **falling** intonation	Greeting					
Stroke dolphin	Touching					
Music-box **gently**	Music	----------	---------	----------		

Postures and Gestures (BLOCK 2)						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Grab **nose**						
Pat both tights with both hands						
Shake head for no						
Form and open **fist**						
Pretend to **drink from baby-bottle**						
Protrude **tongue**		----------				
Shrug shoulders						
Pretend to **throw a ball**						
Close and open **eyes**		----------				
Pat elbow						
Pull both ears with both hands ipsilateral						
Happy face		----------				

Instrumental Acts on Unfamiliar Objects						
	Accurate	Incorrect	Non-compliance	Outcome achieved	Comments	2nd trial
Giggly dumbbell				giggly noise		
Bone				sticker		
Light-box				light flashes		
Squeaking-box				squeaking noise		

Nonwords and Words										
Nonword	**Scoring**			**2nd trial**	**Response**	**Word**	**Scoring**		**2nd trial**	**Response**
/'du:fɐ/ (2)	1	0	R							
/lʊp/ (1)	1	0	R							
Target nonword						**Target word**				
/do:l/ (1)	1	0	R			/'wɪpə/ (2)	1	0	R		
/'ty:le/ (2)	1	0	R			/baǫm/ (1)	1	0	R		
/'po:və/ (2)	1	0	R			/bɛt/ (1)	1	0	R		
/nʊ'nu:bə/ (3)	1	0	R			/'laęte/ (2)	1	0	R		
/'a:zʊmə/ (3)	1	0	R			/ba'na:nə/ (3)	1	0	R		
/tʊp/ (1)	1	0	R			/'nu:dəl/ (2)	1	0	R		
/'di:nəl/ (2)	1	0	R			/'a:maezə/ (3)	1	0	R		
/maęp/ (1)	1	0	R			/li:t/ (1)	1	0	R		
/e:fo:'lɪnt/ (3)	1	0	R			/e:lə'fant/ (3)	1	0	R		
SUM										

Pretend Acts with Substitute Objects						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Practice trial: Put sponge on your head and then in the tower						
Brush hair with **spoon**						
Drink from miniature **hat**						
Phone with **banana**						
Brush teeth with **pencil**						

LEVEL 1 2-word-uterances and 2-word-sentences **practice items:** **- ein Hut** **- Anna malt**	**1**	Bonbon essen Bonbon | essen	1 0	R
	2	Mamas Bett Mama | possessive ‚s' | Bett	1 0	R
	3	Schuhe aus Schuh | plural | particle	1 0	R
	4	Lass das! lassen | imperativ | pronoun	1 0	R
	5	Lena rennt. Lena | rennen | 3rd sing	1 0	R
	6	Ich baue. pronoun | bauen | 1st sing	1 0	R
LEVEL 2 simple sentence structure	**7**	Der Hund bellt. (3) def art | Hund | bellen | 3rd sing	1 0	R
	8	Sie hat gebadet. (3) pronoun | haben | 3rd sing | baden | participle II	1 0	R
	9	Die Blumen sind schön. (4) (adjective in predicate position) def art | Blume | plural | sind | 3rd plural | schön	1 0	R
	10	Du malst einen Mann. (4) pronoun | malen | 2nd sing | indef art | inflection | Mann	1 0	R
	11	Er hat den Teddy gefunden. (5) pronoun | haben | 3rd sing | def art | inflection | Teddy | finden | participle II	1 0	R
	12	Die Babys trinken ihre Milch. (5) (plural + possessive pronoun) def art | Baby | Plural | trinken | 3rd plural | posspronoun | Milch	1 0	R
LEVEL 3 more complex structures with additional elements	**13**	Ich singe kein Lied. [4] (negation) pronoun | singen | 1st sing | negation | Lied	1 0	R
	14	Tom klettert auf einen Baum. [5] (prepositional object) Tom | klettern | 3rd sing | preposition | indef art | inflection | Baum	1 0	R
	15	Die Kinder mögen kleine Enten. [5] (adjective-attribute) def art | Kind | plural | mögen | 3rd plu | klein | Ente | plural	1 0	R
	16	Den Hasen füttert die Oma. [5] (topicalisation accusative object) def art | Hase | Inflection | füttern | 3rd sing | def art | Oma	1 0	R
	17	Anna wird von Jan geküsst. (5) (passive construction) Anna | werden | 3rd sing | preposition | Jan | küssen | Participle II	1 0	R
	18	Heute geht sie in den Laden. [6] (topicalisation time adverb) Heute | gehen | 3rd sing | pronoun | preposition | def art | inflection | Laden	1 0	R
	19	Er gibt dem Jungen das Buch. [6] (2 objects: dative + accusative) pronoun | geben | 3rd sing | def art | Junge | inflection | def art | Buch	1 0	R
	20	Sie weint, weil sie traurig ist. [6] (subclause) pronoun | weinen | 3rd sing | conjunction | pronoun | traurig | sein | 3rd sing	1 0	R
TOTAL				

C.2 Data sheet version B

DATA SHEET VERSION B

code: date of birth: assessment date:

range: age: gender:

Mouse-house (version B)						
	Outcome achieved	Detail accurate	Detail Incorrect	Detail not considered	Comments	2nd trial
Door closed	in house				**chimney** **door**	
Mouse **slides** (with house)	in house	slides				
Mouse **falling** intonation *hui* (**slides** to house)	in house	falling intonation				
Door open	in house				**chimney** **door**	
Mouse **slides** (without house)	movement	slides				

Postures and Gestures (BLOCK 2)						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Practice trial: Raise both arms straight above head						
Grab **nose**						
Pat both tights with both hands						
Shake head for no						
Form and open **fist**						
Pretend to **drink from baby-bottle**						
Protrude **tongue**		----------				
Shrug shoulders						
Pretend to **throw a ball**						
Close and open **eyes**		----------				
Pat elbow						
Pull both ears with both hands ipsilateral						
Happy face		----------				

Present game (Version B)						
	Outcome achieved	Detail Accurate	Detail Incorrect	Detail not considered	Comments	2nd trial
Xylophone **gently**	Music					
Police-car **fist**	Car moves					
Dolphin **rising** intonation	Greeting					
Tap dolphin	Touching					
Music-box **forcefully**	Music	----------	--------	--------		

Postures and Gestures (BLOCK 1)						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Pat top of head with one hand						
Waving for greeting						
Lift one finger						
Pretend to **sleep**						
Touch shoulder						
Finger to lips for quiet						
Open and close mouth		----------				
Pretend to **eat with spoon**						
Form **T-sign** with hands						
Pull one ear						
Angry face		----------				

Pretend Acts with Substitute Objects						
	Accurate	Partial	Unrelated	Non-compliance	Comments	2nd trial
Practice trial: Put sponge on your head and then in the tower						
Brush hair with **spoon**						
Drink from miniature **hat**						
Phone with **banana**						
Brush teeth with **pencil**						

Nonwords and Words									
Nonword	**Scoring**		**2nd trial**	**Response**	**Word**	**Scoring**		**2nd trial**	**Response**
/'du:fe/ (2)	1 0	R							
/lʊp/ (1)	1 0	R							
Target nonword					**Target word**				
/do:l/ (1)	1 0	R			/'wɪpə/ (2)	1 0	R		
/'ty:le/ (2)	1 0	R			/baǫm/ (1)	1 0	R		
/'po:və/ (2)	1 0	R			/bɛt/ (1)	1 0	R		
/nʊ'nu:bə/ (3)	1 0	R			/'laęte/ (2)	1 0	R		
/'a:zʊmə/ (3)	1 0	R			/ba'na:nə/ (3)	1 0	R		
/tʊp/ (1)	1 0	R			/'nu:dəl/ (2)	1 0	R		
/'di:nəl/ (2)	1 0	R			/'a:maezə/ (3)	1 0	R		
/maęp/ (1)	1 0	R			/li:t/ (1)	1 0	R		
/e:fo:'lɪnt/ (3)	1 0	R			/e:lə'fant/ (3)	1 0	R		
SUM									

Instrumental Acts with Unfamiliar Objects						
	Accurate	Incorrect	Non-compliance	Outcome achieved	Comments	2nd trial
Giggly dumbbell				giggly noise		
Bone				Sticker		
Light-box				light flashes		
Squeaking-box				squeaking noise		

LEVEL 1 2-word-uterances and 2-word-sentences **practice items:** **- ein Hut** **- Anna malt**	**1**	Bonbon essen Bonbon | essen	1 0	R
	2	Mamas Bett Mama | possessive ‚s' | Bett	1 0	R
	3	Schuhe aus Schuh | plural | particle	1 0	R
	4	Lass das! lassen | imperativ | pronoun	1 0	R
	5	Lena rennt. Lena | rennen | 3rd sing	1 0	R
	6	Ich baue. pronoun | bauen | 1st sing	1 0	R
LEVEL 2 simple sentence structure	**7**	Der Hund bellt. (3) def art | Hund | bellen | 3rd sing	1 0	R
	8	Sie hat gebadet. (3) pronoun | haben | 3rd sing | baden | participle II	1 0	R
	9	Die Blumen sind schön. (4) (adjective in predicate position) def art | Blume | plural | sind | 3rd plural | schön	1 0	R
	10	Du malst einen Mann. (4) pronoun | malen | 2nd sing | indef art | inflection | Mann	1 0	R
	11	Er hat den Teddy gefunden. (5) pronoun | haben | 3rd sing | def art | inflection | Teddy | finden | part. II	1 0	R
	12	Die Babys trinken ihre Milch. (5) (plural + possessive pronoun) def art | Baby | plural | trinken | 3rd plural | posspronoun | Milch	1 0	R
LEVEL 3 more complex structures with additional elements	**13**	Ich singe kein Lied. [4] (negation) pronoun | singen | 1st sing | negation | Lied	1 0	R
	14	Tom klettert auf einen Baum. [5] (prepositional object) Tom | klettern | 3rd sing | preposition | indef art | inflection | Baum	1 0	R
	15	Die Kinder mögen kleine Enten. [5] (adjective-attribute) def art | Kind | plural | mögen | 3rd plu | klein | Ente | plural	1 0	R
	16	Den Hasen füttert die Oma. [5] (topicalisation accusative object) def art | Hase | inflection | füttern | 3rd sing | def art | Oma	1 0	R
	17	Anna wird von Jan geküsst. (5) (passive construction) Anna | werden | 3rd sing | preposition | Jan | küssen | Participle II	1 0	R
	18	Heute geht sie in den Laden. [6] (topicalisation time adverb) heute | gehen | 3rd sing | pronoun | preposition | def art | inflection | Laden	1 0	R
	19	Er gibt dem Jungen das Buch. [6] (2 objects: dative + accusative) pronoun | geben | 3rd sing | def art | Junge | inflection | def art | Buch	1 0	R
	20	Sie weint, weil sie traurig ist. [6] (subclause) pronoun | weinen | 3rd sing | conjunction | pronoun | traurig | sein | 3rd sing	1 0	R
TOTAL				

C.3 Scoring sheet

AGE ASSESSMENT DATE: CODE CHILD: GENDER: RANGE: VERSION:

Manual Postures						
	Accurate Score = 2	Partial Score = 1	Unrelated Score = 0	Non-compliance Score = 0	Comments	2nd trial
Pat top of head with one hand						
Lift one finger						
Touch shoulder						
Form T-sign						
Pull one ear with one hand						
Grab nose						
Pat both thighs with both hands						
Form and open a fist						
Pat elbow						
Pull both ears with both hands ipsilateral						
SUM (max 20)						

Facial Postures				
	Attempt Score = 1	Non-compliance Score = 0	Comments	2nd trial
Open and close mouth				
Protrude tongue				
Close and open eyes				
SUM (max 3)				

Facial Expressions				
	Attempt Score = 1	Non-compliance Score = 0	Comments	2nd trial
Angry face				
Happy face				
SUM (max 2)				

Object Related Gestures						
	Accurate Score = 2	Partial Score = 1	Unrelated Score = 0	Non-compliance Score = 0	Comments	2nd trial
Pretend to sleep						
Pretend to eat with a spoon						
Pretend to drink from a baby-bottle						
Pretend to throw a ball						
SUM (max 8)						

Conventional Gestures						
	Accurate Score = 2	Partial Score = 1	Unrelated Score = 0	Non-compliance Score = 0	Comments	2nd trial
Waving for greeting						
Shake head for no						
Shrug shoulders						
Finger to lips for quiet						
SUM (max 8)						

Pretend Acts with Substitute Objects						
	Accurate Score = 2	Partial Score = 1	Unrelated Score = 0	Non-compliance Score = 0	Comments	2nd trial
Brush hair with spoon						
Drink from miniature hat						
Phone with banana						
Brush teeth with pencil						
SUM (max 8)						

Instrumental Acts with Unfamiliar Objects (Means)					
	Accurate Score = 1	Incorrect Score = 0	Non-compliance Score = 0	Comments	2nd trial
Shake dumbbell					
Pull bone apart					
Take foam out & move handle of light-box					
Push present					
SUM means (max 4)					

Instrumental acts with unfamiliar objects (Outcome)					
	Outcome achieved Score = 1	Outcome not achieved Score = 0	Non-compliance Score = 0	Comments	2nd trial
Dumbbell giggles					
Sticker obtained					
Light flashes					
Present squeaks					
SUM effect (max 4)					

Outcome (Instrumental Acts with Familiar Objects)					
	Outcome achieved Score = 1	Outcome not achieved Score = 0	Non-compliance Score = 0	Comments	2nd trial
Music (xylophone)					
Police-car moves					
Greet dolphin					
[Touch dolphin]					
Music (music-box)					
Mouse into house I					
Mouse into house II					
Mouse into house III					
Mouse into house IV					
Mouse moves V					
SUM goal (max 10)					

Variation A: Subtask 1 (Action Details)					
	Accurate Score = 1	Incorrect Score = 0	Non-consideration Score = 0	Comments	2nd trial
Xylophone forcefully					
Police-car finger					
Dolphin falling intonation					
[Stroke dolphin]					
[Twist music-box gentle]					
Mouse hops (with house)					
Mouse rising intonation (mouse hops to house)					
Mouse hops (no house)					
SUM details (max 6/8)					

Variation B: Subtask 1 (Action Details)					
	Accurate Score = 1	Incorrect Score = 0	Non-consideration Score = 0	Comments	2nd trial
Xylophone gently					
Police-car fist					
Dolphin rising intonation					
[Tap dolphin]					
[Twist music-box forceful]					
Mouse slides (with house)					
Mouse falling intonation (mouse slides to house)					
Mouse slides (no house)					
SUM details (max 6/8)					

Subtask 2: Rational Imitation				
	Rational Score = 1	Irrational Score = 0	Comments	2nd trial
Door (door closed)				
Chimney (door open)				
SUM (max 2)				

Part 1: Postures and Gestures		
Manual Postures	(max 20)	
Facial Postures (max 3)		
Facial Expressions (max 2)		
SUM FACIAL	(max 5)	
Object Related Gestures (max 8)		
Conventional Gestures (max 8)		
SUM GESTURES	(max 16)	
Part 2: Actions on Objects		
PRETEND ACTS	(max 8)	
Means Instrumental Acts (max 4)		
Outcome Instrumental Acts (max 4)		
SUM Instrumental acts on unfamiliar objects	(max 8)	
OUTCOMES Instrumental acts on familiar objects	(max 9/10)	
ACTION DETAILS Subtask 1	(max 6/8)	
RATIONAL IMITATION Subtask 2	(max 2)	

Part 3: Verbal Imitation		
Words (max 9)		
Nonwords (max 9)		
TOTAL WORDS + NONWORDS	(max 18)	
SENTENCES TOTAL	(max 20)	

C.4 Scoring criteria

IN GENERAL

Practice items

The aim of the practice items is to familiarise the child with the task. Responses are not scored and correct responses are not required to proceed to the test items. Practice items will be administered at the beginning of:

- the first postures and gestures block (one item)
- the task pretend acts with substitute objects (one item)
- the task imitation of nonwords (two items)
- the task imitation of sentences (two items).

Calculation of the sum of raw scores

- Depending on the construction of the task, items can either be scored with 0, 1 or 2 points. The specified scoring criteria for each task are described in the following. The scoring for each item (0, 1 or 2 points) can be entered next to the item in the appropriate column at the scoring sheet.
- The following four tasks allow for partial imitation:
  - manual postures
  - object related gestures
  - conventional gestures
  - pretend acts with substitute objects
- To score the sum of raw scores for each task, the numbers of items scored 1 point and/or 2 points (see above) are added up and the total is entered in the appropriate box at the foot of the column for each task.

Aided response

If the child insists on reproducing the imitative act with the help of a parent, together with the instructor or via a soft toy instead of acting it out by her/himself, the response will be scored as partial attempt. Importantly, an aided response has to be initiated by the child and not by an adult.

Examples of aided responses:

- The child moves parts of the parents/carers body to act out postures and gestures.
- The child acts out a pretend act on/with the parent/carer, e.g. holds the banana close to the parent's/carer's ear or places the miniature hat on the parent's/carer's head.
- The child insists that she/he can only produce an imitative act when the instructor or parent/carer is also acting out the target act in parallel.

Number, timing and order of presentations

- Number of presented trials by the instructor: The general procedure allows for two trials per item. In all nonverbal trials, each target item is demonstrated twice before the child is invited to act. In all verbal trials, each target item is demonstrated once before the child is invited to act. In total, then, children observe nonverbal items up to four times and verbal items up to two times. The administration of a second trial does not affect scoring but is noted on the score sheet, i.e. the information that the second trial has been administered can be marked by ticking the box 2nd trial at the end of each row for each item.
- Number of imitation presentations per item by the child: When the child performs more than one imitative response, the first response to each item is scored unless the child spontaneously self-corrects herself/himself (without any hint or help from outside), in which case the self-corrected response is scored.

Discontinuation rules

- No discontinuation rules apply in the following tasks (unless the child refuses to cooperate):
  - *Common instrumental acts on familiar objects* (i.e. mouse house and present game)
  - *Common instrumental acts with unfamiliar objects*
  - *Pretend acts with substitute actions*
- *Postures-and-gestures-block 1 and/or 2*: The first six items of a block are administered to all children, but when a child does not respond to any of these six items, the block is discontinued and all remaining items are scored as non-compliance (0 points).
- *Nonwords and words*: The first five test items of both tasks are administered to all children but if the child does not respond to any of these five items, the task is discontinued and all remaining items are scored as non-compliance (0 points). However, if the child attempts at least one of the first five nonwords or words, all test items of the task are administered.
- *Sentences*: Test items of Level 1 are administered to all children, but if the child does not respond to any of these six items the task is discontinued and all remaining items are scored as non-compliance (0 points). However, if a child attempts at least one sentence at Level 1, all items of Level 2 are administered. The same procedure applies for Levels 2 and 3.

PART 1: POSTURES & GESTURES

All manual postures, object related and conventional gestures, facial postures and expressions are mixed and presented together but divided into two blocks, separated by other tasks to keep children engaged. There is one *practice item* for the first *postures and gestures block* which will not be added to the sum of raw scores. In the following you will find the general scoring criteria, a description and a photo of an accurate imitation (2 points) and examples of partial imitation (1 point) for all postures, gestures and facial expressions.

MANUAL POSTURES

General scoring criteria

0 points: The child's response shares no features with the modelled act (**unrelated**) OR the child does not attempt to imitate the item (**non-compliance**).

1 point: The child's response shows some similarities with the modelled target act in terms of chosen body parts and/or plane and direction of manner of movement (**partial**).

2 points: The child reproduces the entire body movement as specified below in terms of changes in posture and location (**accurate**).

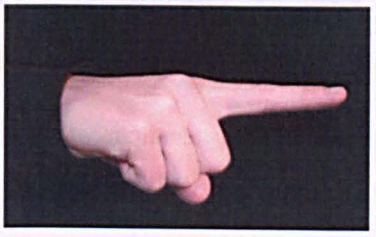
Pat the top of the head with one hand

Description: Lift one arm up to the level of your head (it is not important where the arm was or where around the body it will be lifted up) and place one hand on top of your head (at least 1/3 of the hand needs to touch the hair; the hand does not need to be straight; it is not important where exactly on the head the hand is placed; head is where hair grows, excluding forehead, ears and neck).

Examples of partial scoring:

- the hand goes towards the head but the hand is not clearly placed on the head (e.g. only one finger touches the head)
- the hand is predominantly placed at the face, the forehead, one ear or the neck

Lift one finger up



Description: Curl the fingers/thumb of one hand or make a fist (it is not important how much the fingers/thumb are curled and where and how exactly they are placed; the palm should face down, i.e. the position of the hand may vary regarding the movement at the wrist up and down but the movement sideward should not be more than a 45 degree angle; it is not important how the hand is related to the

body but it should not rest on any part of the body or elsewhere) and lift one finger up (it is not important which finger is lifted; the finger does not need to be straight but the angle between the first and second half of the finger should be less than 90) degrees).

Examples of partial scoring:

- the child lifts the thumb instead of a finger
- the child lifts more than one finger or one finger and the thumb
- the finger-lifting-hand or wrist rests somewhere (e.g. a thigh, the hip, the floor, the chest)

Flex one arm at the elbow and touch the shoulder with the hand

Description: Move one hand and lower arm towards the shoulder of the same arm (plane and position of upper and lower arm in relation to the body are not important) and touch the shoulder with the hand (it is sufficient if either some fingers or the palm partly touch the shoulder, it does not have to be the whole hand; it is not important where fingers or palm touch the shoulder, i.e. towards the chest/collarbone, the upper arm or the neck; it is not necessary to move hand and lower arm back).

Examples of partial scoring:

- the child touches the contralateral shoulder or chest
- the child does not touch the shoulder at all (e.g. only head or chest)

Form a T-sign with both hands

Description: The ***upper hand*** is held in front of the body (the exact relation to the body is not important but the hand should not rest on any other part of the body than the second hand), palm facing downwards approximately parallel to the floor (the movement of the wrist should not exceeds an angle of 45 degrees in any direction), fingers are approximately straight. The ***lower hand*** is placed in a right angle to the palm or fingers of the upper hand to form a T-shape (the angle between the fingertips of the lower hand and the upper hand does not exceed 45 degrees). The palm of the lower hand faces towards the lower arm of the upper hand (the angle between the palm of the lower hand and the lower arm of the upper hand does not exceed 45 degrees). It is not important which hand is the upper and lower hand and the fingers of the lower hand can touch the upper hand at any place. The fingers of the lower hand do not need to touch the upper hand but the gap between the upper and lower hand should not exceed 2cm.

Examples of partial scoring:

- the child puts both palms together
- the angle between the fingers and the palm of the upper hand exceeds 45 degree, i.e. the fingers are snapped off

- the palm of the lower hand faces horizontal/parallel towards the body, i.e. is not facing towards the lower arm of the upper hand
- the outside of the lower hand - instead of the palm - is facing towards the lower arm of the upper hand
- the gap between the upper and lower hand exceeds 2 cm

Pull one ear with one hand

Description: One hand moves towards one earlobe (it is not important which hand or which ear and the movement can either be ipsilateral or contralateral; the child does not need to touch or pull the ear(lobe) but the fingers are in a position as if they would pull an earlobe even when they miss it; it can be any part of one ear and does not exactly has to be the earlobe).

Examples of partial scoring:

- the child pulls both earlobes
- the child only touches the hair or cheek

Grab the nose with the thumb and the index finger of one hand

Description: Lift one hand up to the level of the face and grab the nose with the thumb and the index finger of this hand, palm facing towards the nose (the fingers need to touch the nose but it is not important which hand is used and where exactly the fingers grab the nose).

Example of partial scoring: the child uses both hands to grab the nose

Pat both thighs with both hands

Description: Both hands approximately simultaneously pat both thighs and/or knees ipsilateral (It is not important where exactly between the hips and knees the hands pat the thighs and which parts of the hands in which shape pat the thighs). It is still accurate if the hands reach the thighs slightly one after the other but there needs to be a clear downwards movement.

Example of partial scoring: the child lays both hands on both thighs and strokes the knees/thighs without a clear downwards movement (patting)

Form and open a fist with one hand


Description: First form a fist with one hand, i.e. curl the fingers towards the palm of the hand (it is not important which hand is used and where exactly the thumb is placed but the palm should face up; the position of the hand and forearm in relation to the rest of the body is not important but the hand itself should not rest on any part of the body or elsewhere). Then open this fist, i.e. all fingers and the thumb are approximately extended. It is not necessary to close the fist again.

Examples of partial scoring:

- the child uses both hands
- the palm is not facing up, i.e. the sideward movement of the wrist is more than 90 degree to either side

Pat the elbow of one arm with the hand of the other arm

Description: Bring the palm and/or fingers of one open hand towards the elbow of the contralateral arm and pat the elbow with this hand (it is not important which hand or which parts of the inner hand touch the contralateral elbow as long as the hand is not closed to a fist; the exact relation of the contralateral arm and elbow to the body is not important but neither the arm, elbow or hand should rest anywhere). The ***direction of movement*** of the hand towards the contralateral elbow is bottom-up and not top-down, i.e. the hand reaches the elbow at the bottom of the contralateral arm and the lower arm of the contralateral arm is always above the lower arm of the hand that pats the elbow. The ***manner of movement*** is patting and not stroking.

Examples of partial scoring:

- the child touches the crook of the contralateral arm instead of the elbow
- the child strokes the elbow instead of patting it
- the movement of the hand towards the contralateral elbow is top-down, i.e. the lower arm of the contralateral arm is below the upper arm of the hand that moves towards the elbow
- the inner hand does not touch the elbow of the contralateral arm, i.e. there is a gap between the hand and the elbow
- the hand that touches the contralateral elbow has the shape of a fist

Pull both ears with both hands ipsilateral

Description: Both hands approximately simultaneously and ipsilateral move towards both earlobes (the child does not need to touch or pull the ear(lobe)s but the fingers are in a position as if they would pull both earlobes even when they miss them; it can be any part of the ear and does not exactly has to be the earlobe).

FACIAL POSTURES

General scoring criteria

0 points: The child does not attempt to imitate the target act, i.e. makes no facial movements (**non-compliance**).

1 point: The child attempts to imitate the target act, i.e. moves relevant parts of the face (**attempt**).

Open and close mouth

Description: The child tries at least to open the mouth, i.e. shows any movement of the lips.

Protrude tongue

Description: The child tries to protrude the tongue, i.e. shows any movement of the tongue within or outside the mouth, lips either touching the tongue or not.

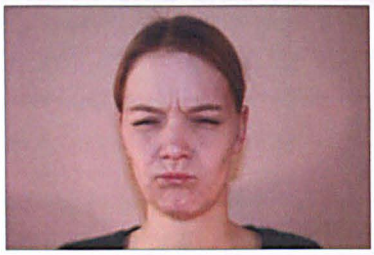
Close and open eyes

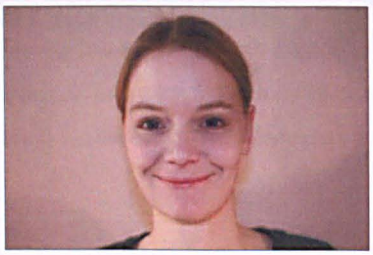
Description: The child tries at least to close the eyes, i.e. shows a movement of the eyes and/ or eyelids.

FACIAL EXPRESSIONS: Angry face and happy face

0 points: The child does not attempt to imitate the target act, i.e. makes no facial movements (**non-compliance**).

1 point: The child attempts to imitate the target act, i.e. the child tries to mime a facial expression and moves parts of the face in an attempt to mime (**attempt**).





OBJECT RELATED GESTURES

General scoring criteria

0 points: The child's response shares no features with the modelled act (**unrelated**) OR the child does not attempt to imitate the item (**non-compliance**).

1 point: The child's response is a visible attempt to establish a reference to the use of a target object but with inaccuracies in the representation of the object shape and/or its use (**partial**).

2 points: The child reproduces a comprehensible gestural act that represents without doubt the shape and use of an object (**accurate**). Noises accompanying the gestures are possible but not necessary, i.e. any gesture without an accompanying noise like snoring, smacking etc. can be accurate and thus scored with two points.

Pretend to sleep on a cushion

Description: Pretend to form a cushion, either with two hands or with one hand (it is not important which hand is used to pretend the cushion but the other 'free' hand should not be involved in the performance of the gesture). Bend the head towards one shoulder, position the substitute cushion between the ear and the shoulder and pretend to sleep (it is not important towards which shoulder the head is bent; the hand(s) forming the cushion can touch the shoulder and/or ears but don't have to). There can be an accompanying snoring noise and the eyes can be (partially) closed but both details are not necessary to achieve an accurate gesture.

Example of partial imitation: the child places one hand on one ear and the other hand on the other ear

Pretend to eat with a spoon

Description: Pretend to hold the handle of a spoon with one hand by performing a grasping movement around an imaginary spoon-handle (it is not important which hand is used *but it needs to be one* hand). The ***manner of the grasping movement*** can be acted out in different ways and does not have to be a precise mirror image of the modelled object but it needs to be apparent that the child pretends to grasp an object like a spoon with one hand (i.e. the fingers can be curled in different ways, the thumb can be placed in different ways on or around the fingers of the hand, the wrist can be in different positions and the opening for the spoon-handle can be of different round shapes). Move the hand that pretends to hold the spoon towards the mouth and pretend to bring imaginary food towards/into the mouth. The ***direction and manner of the eating movement*** is a single and consistent movement that is clearly directed towards the mouth. The spoon-hand can touch the lips/mouth but does not have to. Chewing movements and smacking noises with open or close lips can be performed but are not necessary for an accurate gesture.

Examples of partial imitation:

- the direction and manner of the eating movement is not consistently and clearly directed towards the mouth, i.e. the hand that pretends to hold the spoon moves either around the mouth or towards the head
- the child makes a smacking noise and moves the lips but does not pretend in to bring a substitute spoon towards the mouth
- the child moves an open hand towards the mouth without any sign to hold a spoon
- the child moves both hands towards the mouth

Pretend to drink from a baby-bottle

Description: Pretend to hold a (baby-)bottle in one hand by performing a grasping movement around a round-cylindrical shaped object (it is not important which hand is used but it needs to be one hand).The ***manner of the grasping movement*** does not need to be a precise mirror image of the modelled object regarding its shape and dimensions but fingers and thumb need to be curled as if holding a circular-cylindrical bottle with all fingers on one side and the thumb on the opposite side. It is not important if and how large the gap between the finger tips and the tip of the thumb is, i.e. it can also be a very thin bottle where the gesture reminds of a fist. Move the hand that pretends to hold the bottle towards the mouth and pretend to drink imaginary liquid. The ***direction and manner of the drinking movement*** is a consistent movement that is clearly directed towards the mouth. The bottle-hand can touch the lips but does not have to. The head might be bend a little bit towards the neck but does not need to. The exact position of the bottle in relation to the body is not important but the nozzle of the bottle should

point towards the mouth. Drinking/sucking movements and smacking noises with open or close lips can be performed but are not necessary for an accurate gesture.

Examples of partial imitation:

- the manner of the drinking movement is not clearly and consistently directed towards the mouth, i.e. the hand pretending to hold the bottle moves either around the mouth or quickly back and forth somewhere close or around the mouth
- the child makes a drinking noise, moves the lips and bends the head towards the neck but does not pretend in any way to bring a substitute bottle towards the mouth
- the child moves an open hand towards the mouth without any sign to hold a bottle
- the child brings both hands towards the mouth

Pretend to throw a ball


Description: Pretend to hold a ball in one hand by performing a grasping movement around a round shaped object (it is not important which hand but it needs to be one hand). The ***manner of the grasping movement*** does not need to be a precise mirror image of the modelled object regarding its shape and dimensions but all fingers and the thumb are curled and placed as if they were holding a small or middle sized ball. The ***direction and manner of the of the throwing/catching movement*** is forwards-turned and straight or top-down, starting at the level of the head, shoulder or thorax or behind and is a continuous movement that ends in front of the child. It is not important if the child pretends to throw or catch a ball as long as the direction of the movement is correct. A throwing noise can be performed but does not need to be performed

Examples of partial imitation:

- The direction of the throwing/catching movement in bottom-up instead of top-down
- The direction of the throwing/catching movement is backwards or up and down instead of forwards-turned

CONVENTIONAL GESTURES

0 points: The child's response shares no features with the modelled act (**unrelated**) OR the child does not attempt to imitate the item (**non-compliance**).

1 point: The child's response is a visible attempt to represent a specific social function but the gesture is inaccurate and/or the target content is uncertain (**partial**).

2 points: The child reproduces a comprehensible gestural act that represented without doubt a specific social function (**accurate**).

Waving for greeting

Description: Wave one hand as if to greet someone (it is not important which hand but it needs to be one hand). The exact position of the hand in relation to the body is not important and it is accurate if the elbow of the arm with the waving hand leans on a body part or elsewhere. The palm of the hand faces towards the imaginary person, fingers might be slightly curled. The ***manner of the waving movement*** can be acted out in two different ways:

- by moving the waving hand sideward (from the thumb-side to the to the side of the little finger) or
- by opening and closing all fingers and the thumb simultaneously as if opening and closing a fist

Example of partial imitation: the child waves with both hands (but it is accurate when the child upholds the hand that doesn't wave without movement)

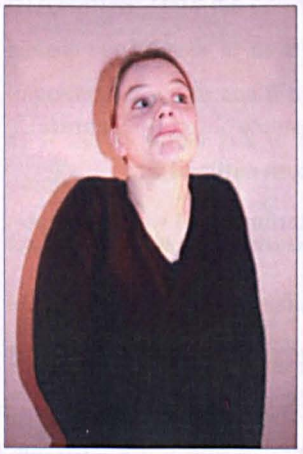
Finger or thumb to lips for quiet

Description: Bring any single finger or thumb of one hand in one continuous movement towards or at the mouth/lips as if to try to quieten someone down (the lips might be closed or slightly open and can be rounded but don't need to be).

Example of partial imitation:

- the child moves more than one finger or the whole hand towards the mouth/lips
- the child moves a finger/thumb towards the nose or cheek instead of towards the mouth/lips

Shrug shoulders for puzzlement



Description: Lift both shoulders approximately simultaneously upwards to the ears as if to express to be puzzled. A puzzled facial expression can be added but doesn't need to be added.

Examples of partial imitation:

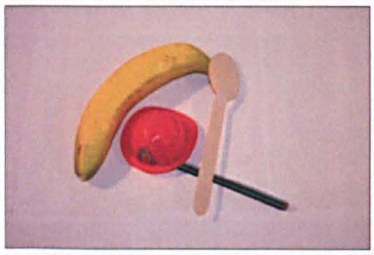
- the child tries to move the whole chest/thorax up and down or sideward instead of solely the shoulders
- the child tries to pull the head downwards between the shoulders instead of lifting the shoulders upwards to the ears

Shake head for negation

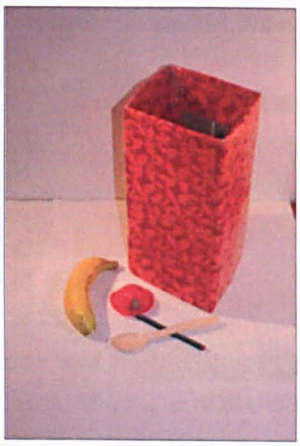
Description: Shake the head at least once to both shoulders as if to communicate negation. It is accurate if the shaking movement is only minimal.

PART 2: ACTIONS ON OBJECTS

PRETEND ACTS WITH SUBSTITUTE OBJECTS



Practice items: There is one practice item for the task *pretend acts* (which will not be added to the sum of raw scores).



General scoring criteria

0 points: The child's response shares no features with the modelled act (**unrelated**) OR the child does not attempt to imitate the item (**non-compliance**) OR the child throws the object into the tower without attempting to imitate the target act (**refusal**).

1 point: Two types of **partial** imitation:
The child's response shows inaccuracies in the use of the substitute object (**inaccurate**).
The child uses the substitute object in its conventional way (**conventional**).

2 points: The child uses the substitute object in the demonstrated counterfunctional way (**accurate**).

Comb hair with spoon

Description: Hold the spoon at the handle in one hand (it is not important which hand or how the child grasps the spoon handle but it needs to be one hand) and act as if combing the hair with a comb, i.e. moving the spoon along the hair. It is not important how many brushing movements are acted out, if the direction of the brushing movement is top-bottom or bottom-up and if the spoon touches the hair or not. But the brushing movement needs to involve the top, side or back of the head where you can see hair.

Example of partial imitation:

- the child only brushes the fringe
- the child moves the spoon only in front of her/his face
- the child uses both hands to move the spoon
- the child acts as if she/he would eat imaginary food from the spoon
- the child holds the spoon in her/his hands, looks puzzled and comments something like: 'It's a spoon. We eat with it.'

Drink from miniature hat

Description: Hold the hat with one hand as if holding a cup (it is not important which hand or how exactly the child holds the hat but it needs to be one hand and the bottom side of the hat must be at the top) and move the hat with one continuous movement towards the mouth as if drinking liquid from a cup (it is not important if the hat touches the lips or not). For an ***accurate imitative act*** (2 points) the child can but does not need to:

- Move/open the lips and/or
- make smacking noises and/or
- throw her/his head back and/or
- cant the cup towards her/his mouth

Examples for partial imitation (1 point):

- the child places the hat on her/his head
- the child comments something like: 'You cannot drink out of a hat' or 'This is a fireman's hat'

Phone with banana

Description: Hold the banana in one hand (it is not important which hand or how the child grasps the banana but it needs to be one hand) and move it towards one ear as if phoning with someone (it is not important which ear and if the banana touches the ear or not). The child can move the lips or actually talk as if she/he would talk to an imaginary person but this is not necessary for an accurate imitation (2 points).

Examples of partial imitation:

- the child acts as if she/he would eat the banana
- the child acts as if she/he would peel the banana
- the child holds the banana in front of her/his mouth (although not eating)
- the child asks: 'Can I eat it?'

Brush teeth with pencil

Description: Hold the pencil in one hand as if holding a toothbrush at it's handle. It is not important which hand grasps the pencil but it needs to be one hand and at least part of the hand that holds the pencil should touch the backmost 2/3s of the pencil in relation to the mouth. It is not important how exactly the fingers and the thumb are curled around the pencil but the hand-ankles should be above or sideward of the pencil, i.e. like holding a toothbrush and not like holding a pencil. Move the pencil in one continuous movement close towards the mouth and make small see-saw movements parallel to the lips as if brushing the teeth. The direction and manner of movement is backwards-forwards or the other way round. It is not important if the movement is straight or not, if the pencil touches the mouth or not and how many movements are acted out. The child can open the lips and show her/his teeth or make brushing noises but this is not necessary to for an accurate imitation (2 points).

Examples of partial imitation:

- the child holds the pencil with two hands
- the child holds the pencil only at the first third (regardless if peak or back)
- the child makes large rotary movements far away in front of the mouth
- the child makes brushing movements in front of a different part of the face, e.g. the eyes, the forehead or the hair
- the child holds the pencil like a pencil and either draws on a sheet of paper or watches out where she/he could draw on
- the child comments something like: 'This is not a toothbrush - it's a pencil.' or 'I want to draw a picture – can you give me a sheet of paper'.

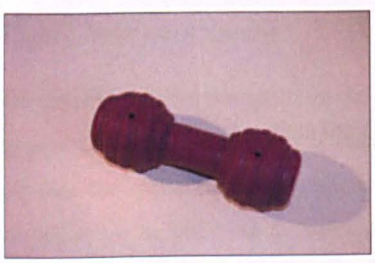
INSTRUMENTAL ACTS WITH UNFAMILIAR OBJECTS (MEANS)

General scoring criteria

0 points: The child's response shows inaccuracies in acting out the use of a novel object (**inaccurate**) OR the child does not attempt to imitate the item (**non-compliance**).

1 point: The child imitates the use of the object with the means demonstrated to produce the outcome (**accurate**). The causation of the outcome is *not necessary* for an accurate imitation.

Shake giggly dumbbell

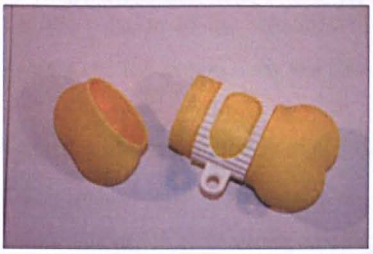


Description: Hold the dumbbell in one hand at its handle (the part between the two weights and not the weights themselves) and shake it in the air. The ***direction of the shaking movement*** can either be up and down or sideward, i.e. vertical or horizontal. It is not important which hand holds the handle or how exactly the child holds the dumbbell but it needs to be only one hand and neither the dumbbell nor the holding hand should rest on any body part or elsewhere.

Scoring examples:

- the child holds the dumbbell with two hands (0 points)
- the child rolls the dumbbell over the floor (0 points)
- the child shakes the dumbbell through moving it up and down (1 point)
- the child shakes the dumbbell from one side to the other/sideward but it does not make any noise because it is too heavy for the child (1 point)

Pull both sides of the bone apart



Description: Hold both halves of the bone each with one hand and pull them apart to two opposite directions to open the bone (it is not important if the bone rests anywhere or not).

Scoring examples:

- the child squeezes the two halves together instead of pulling them apart (0 points)
- the child knocks the bone on the floor (0 points)
- the child hands the bone over to her/his mother to open it (0 points)

Take out the rubber foam and move the lever of the light-box

Description: Hold the light-box in one hand (it is not important which hand and how) and then

- first take out the piece of rubber form and
- secondly move the lever completely from one side of the opening to the other side of the opening (it is not important how the lever is held or moved)

It is sufficient for an accurate imitation (1 point) to move the lever once completely from one side to the other side but the child might also move the lever several times if she/he likes (to enjoy the flashing light).

Scoring examples:

- the child only moves the lever half way from one side to the other (0 points)
- the child tries to move the lever without taking out the rubber foam (0 points)

Hold the present on its handle and push it upside down on the floor

Description: Hold the present with one hand on it's handle and then push the present upside down on the floor (it is not important which hand holds the handle and how the lever is held but it needs to be one hand around the handle).

Scoring examples:

- the child holds the handle of the present with two hands (0 points)
- the child holds the present at its body and not at its handle (0 points)

INSTRUMENTAL ACTS WITH UNFAMILIAR OBJECTS (OUTCOMES)

General scoring criteria

0 points: The child does not achieve an outcome.

1 point: The child achieves an outcome.

Purple dumbbell giggles

Description: The dumbbell produces a giggling noise (any noise, even one weak giggle, counts as effect)

Obtain sticker

Description: Find and get the sticker that was hidden inside the bone (it is ok if the sticker for any reason still sticks inside one half of the bone)

Light flashes

Description: The 'google'-light starts to flash in different colours (it doesn't matter how long the light flashes)

Present squeaks

Description: The box makes a squeaking noise.

INSTRUMENTAL ACTS ON FAMILIAR OBJECTS (OUTCOMES)

General scoring criteria

0 points: The child does not achieve an outcome
OR does not attempt to imitate the item.

1 point: The child achieves an outcome.

PRESENT GAME

Play xylophone

Description: The child needs to play/hit at least one tone-plate of the xylophone once with the drumstick to evoke a noise/tone (it is not important how the child holds the drumstick or how loud and long the produced tone/noise is or in which manner the xylophone is played).

Start police car

Description: The child needs to press the hat of the police man to start the movement of the police car, i.e. the rotation of the wheels (it is not important with which body part or in which manner the child presses the hat or how long the police car keeps driving).

Greet soft toy (dolphin)

Description: The child needs to greet the dolphin verbally, e.g. with *hello* or *hi dolphin* (it is not important which welcoming word/phrase is used to greet the dolphin or which intonation is used).

Touch soft toy (dolphin)

Description: The child needs to touch the dolphin with her/his hand and to move the hand across the dolphin in any manner or any direction. It is not important in which hand the child holds the dolphin, which parts of the hand are touching the dolphin, in which manner and style the dolphin is touched or in which direction the hand is moved (i.e. from head to tail, tail to head, back to belly or belly to back). It is alright when the instructor instead of the child holds the dolphin (1 point).

Play music box

Description: The child needs to turn the handle of the music box to cause music (it is not important how a child holds or moves the handle or how long the music plays).

MOUSEHOUSE

The first four acts involving a mouse, the garden **and** the house (regardless which mouse).

Description: The child needs to bring the mouse into the house but it is not important how the mouse gets ***to*** the house (e.g. hopping, sliding, flying through the air, driving in a car etc.) or how it gets ***into*** the house (i.e. through the chimney or the door).

The last item involving the mouse and the garden but ***not*** *the house*

Description: The child needs to move the mouse ***on*** the garden (i.e. touch the garden at least once briefly) but it is not important in which manner (e.g. hopping, sliding, dancing etc.).

SUBTASK 1: ACTION DETAILS

General scoring criteria

0 points: The child uses a different style or manner of movement than demonstrated in the modelled act (**incorrect**) OR the child fails/ignores to imitate the style or manner of movement (**non-consideration**).

1 point: The child imitates the style or manner of movement demonstrated in the modelled act (**accurate**).

PRESENT

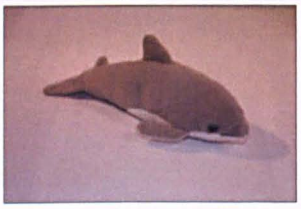
Play xylophone forcefully or gently (style of movement)

Description: The child should play the xylophone in a gentle or forceful manner.

Start police-car with one finger or fist (manner of movement)

Description: The child should press the police-man's-hat with one finger or with a fist to start the driving of the police car. It is not important which finger the child chooses or how the fist is formed.

Greet dolphin with falling or rising intonation (manner of intonation)



Description: The child's intonation while greeting the dolphin should either be falling (like an exclamation, e.g. *Hello!*) or rising (like a question, e.g. *Hello?*).

Stroke or tap dolphin (manner of movement)

Description: The child should either tap or stroke the dolphin. It is not important which hand or which parts of the hand are touching the dolphin, i.e. it might be the whole hand, the palm or some/one finger(s). The manner and direction of the movement is at least one continuous movement, either in the direction top-down (tapping) or in the direction sideward (stroking).

Turn handle of music box forceful or gentle (style of movement)

Description: Do not score this item as it turned out to be too difficult.

MOUSE HOUSE

In general: Only items 2, 3 and 5 provide information about action details.

Mouse slides or hops to house (2nd item: manner of movement):

Description: The child should either hop or slide the mouse from the starting point at the top of the garden (marked by a mouse-sticker) towards the mouse-house. The direction of the movement should be one continuous movement from the start-point to the end-point, i.e. the mouse should not move in zig-zag or circles.

- *Manner of hopping*: The mouse needs to touch the garden at least twice, i.e. 'two hops' are necessary to achieve 1 point.
- *Manner of sliding*: This needs to be one continuous movement but it is alright when the mouse does not constantly touch the garden or when the child did not start the sliding-movement directly at the start-point.

Exclamation hui with falling or rising intonation (3rd item: manner of intonation)

Description: The child should accompany the movement of the mouse towards the house with the exclamation *hui*, that is either produced with a falling (e.g. *Hui!*) or an rising intonation (e.g. *Hui?*). It is not important if the exclamation is exactly *hui* or slightly modified, e.g. *ui* or *wui*. The manner of the movement (i.e. hopping or sliding) has ***no influences*** on the scoring of this item.

Mouse hops or slides across garden (5th: manner of movement)

Description: The child should either hop or slide the mouse across the garden (for details see description of 2nd item). The mouse can move in any direction across the garden as there is no clear start or end-point.

SUBTASK 2: RATIONAL IMITATION

General scoring criteria

0 points: The child does not respond according to the expectations, i.e. chooses the chimney in the first condition, or the door in the second condition.

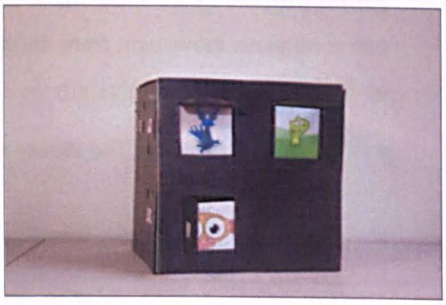
1 point: The child responds according to the expectation, i.e. chooses the door in the first condition, or the chimney in the second condition.

MOUSE HOUSE ITEMS 1 and 4

- **Item 1(condition: door closed)**: the demonstrator used the means of jumping through the chimney instead of using the door to enter the mouse into the house when the door of the house was **closed** -> the child gets 1 point if she/he uses **the open door** to enter the mouse into the house (rational imitation achieved)
- **Item 4 (condition: door open):** the demonstrator used the means of jumping through the chimney instead of using the door to enter the mouse into the house when the door of the house was **open** -> the child gets 1 point if she/he uses **the chimney** to enter the mouse into the house (rational imitation achieved)

PART 3: WORDS, NONWORDS & SENTENCES (VERBAL TASKS)

NONWORDS AND WORDS



Practice items: There are two practice items for the task *nonwords* (which will not be added to the sum of raw scores) but no practice items for the task *words*.

General scoring criteria

0 points: The child attempts to imitate the item but does not produce all and only the target phonemes in the correct order **(incorrect)** OR the child does not attempt to imitate the item **(non-compliance).**

1 point: The child reproduced the entire sequence of phonemes of a word or nonword in the **correct** order with no additions (with allowances: see below).

Allowances were made for all developmental phonological processes but not for delayed and/or unusual phonological processes (regardless if systematic or not). The decision whether a phonological process is typical, delayed or unusual at a certain age is based on the results of Fox (2003).

Specifications/examples:

- When the child omits a ***whole syllable*** within a word or nonword (e.g. Banane -> nane) the item is always scored as inappropriate (0 points) although the omission of initial unstressed syllables would still be typical until the age of 3;4 years.
- When the child substitutes or ***omits any vowel*** within a word and/or nonword the item is always scored as inappropriate (0 points).
- When the child ***interchanges/swaps*** any single vowels, consonants or whole syllables within a word and/or nonword (e.g. Banane –Banena; Nudel -> Dunel; Banane -> Nabane) the item is always scored as inappropriate (0 points).
- When a child ***adds any vowels, consonants or syllables*** within a word and/or nonword (Banane -> Bananane) the item is always scored as inappropriate.

SENTENCES

Practice items: There are two practice items for the task *sentences* (which will not be added to the sum of raw scores).

General scoring criteria

0 points: The child attempts to reproduce the item but does not produce all target morphemes in the correct order (**incorrect**) OR the child did not attempt to imitate the item (**non-compliance**).

1 point: The child reproduces the entire sentence accurately with all morphemes in **correct** order (with allowances for phonological processes, see below).

In this case, allowances were made for all developmental phonological processes (whether they were systematic or not) and for all systematic delayed and/or unusual phonological processes. The decision whether a phonological process was typical, delayed or unusual at a certain age was based on Fox (2003).

Specifications/examples of the scoring criteria

- All ***omissions of initial unstressed syllables*** in *past participle forms* are scored as correct (e.g. gebadet –> badet or gefunden -> funden; 1 point).
- Addition of words is allowed and scored with 1 point when the sentence is still perfectly grammatical and the word order of the sentence has not been changed (e.g. Anna wird von Jan geküsst. -> ***Die*** Anna wird von Jan geküsst. or Die Blumen sind schön. -> Die Blumen sind ***nicht*** schön.).
- All ***substitutions of content words*** which are not due to systematical phonological processes are scored as inappropriate (0 points), regardless if the sentence is still perfectly grammatical and preserved meaning (e.g. Mann -> Bann or Anna -> Anja).
- All substitutions of
  - ***indefinite articles*** into definite articles (e.g. **einen** Baum -> **den** Baum) or
  - ***definitive articles*** into indefinite articles (e.g. **das** Buch -> **ein** Buch) or
  - ***personal pronouns*** into definitive articles (e.g. **Sie** weint, […] -> **Die** weint, [...])

  are scored as inappropriate (0 points), even when the sentence is still perfectly grammatical and the word order of the sentence has not been changed.
- ***Sentence 19***: The substitution of '*Er gibt **dem** Jungen das Buch'.* into '*Er gibt **den** Jungen das Buch'.* is scored as inappropriate (0 points) although this is still a typical grammatical error pattern at the age of 2;0 to 3;5 years.
- ***Sentence 16***: The substitution of '***Den** Hasen füttert die Oma'.* into '***Die** Hasen füttert die Oma'.* is scored as inappropriate (0 points) as the non-canonical structure has not been preserved.

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D Nonverbal imitation errors

MANUAL POSTURES

Types of errors for manual postures associated with the typical and clinical samples (X = error occurred; — = error occurred not)

Item	Type of error	Typical sample	Clinical sample
T-sign	• put palms of both hands together • align t-sign upside down • range of inaccuracies in shape and/or spatial orientation	X	X
Lift one finger	• lift more than one finger up	X	X
Form & open fist	• use both hands • palm points towards floor or sideward	X	X
	• hand rests on body	X	—
Touch shoulder	• hand moves towards different parts of the *contralateral* body side, e.g. chest, shoulder • touch head	X	X
Pat contralateral elbow	• direction of patting-movement top-down instead of bottom-up • pat body part near elbow, e.g. upper/lower arm	X	X
Pull one ear & Pull both ears	• touch body part(s) near ear(s), e.g. cheek, hair, mouth • pull one ear instead of both or both instead of one	X	X
Pat top of head	• pat body parts close to top of head, e.g. forehead, ear	X	X
Pat both thighs	• use one hand instead of both	X	X
Grab nose	• touch body part close to nose, e.g. cheek	X	X

GESTURES

Types of errors for gestures associated with the typical and clinical samples (X = error occurred; — = error occurred not)

Item	Type of error	Typical sample	Clinical sample
Pretend to drink from a baby bottle **Pretend to eat with a spoon**	• inaccurate representation of **object-shape**, e.g. one/both hand(s) move(s) on/in mouth without representing bottle or spoon • inaccurate representation of **object-use**, e.g. object moves towards nose or head • inaccurate representation of **object-shape *and* -use**, e.g. solely smacking	X	X
Pretend to throw a ball	• throwing-movement directed bottom-up instead of straight	X	X
Pretend to sleep	• one hand placed on each ear	X	X
	• inaccurate representation of object-use, e.g. palm lies flat on ear or cheek without any other reference to the use of the object	X	—
Shrug shoulders	• Move whole upper body	X	X
Fingers to lips for quiet	• Finger moves toward body part near mouth, e.g. nose, chin, cheek	X	X
Waving	• Use both hands	X	X
Shake head for no		—	—

PRETEND ACTS

Types of errors for pretend acts (all errors occurred in the typical and clinical samples)

Item	Type of error	
	Conventional	Inaccurate
Brush hair with spoon	Eat with spoon	Brush in front of face
Drink from miniature head	Put hat on head	-----
Phone with banana	Eat banana	Put banana on top of head
Brush teeth with pencil	Draw with pen	Hold pen with both hands or far away from mouth

INSTRUMENTAL ACTS ON UNFAMILIAR OBJECTS

Types of errors for common instrumental acts on unfamiliar objects (all errors occurred in the typical and clinical samples)

Item	Type of error
Shake dumbbell	Shake dumbbell with both hands instead of one hand
Light-box	Try to move leaver without taking out the foamed rubber
Squeaking present	Hold squeaking present at body instead of handle

ACTION DETAILS (WITHOUT ITEM TOUCHING DOLPHIN AND PLAYING MUSIC BOX)

Types of errors for action details (all errors occurred in the typical and clinical samples)

Item	Type of error
Play forceful or gentle	Play forcefully instead of gently or gently instead of forcefully
Press button with finger or fist	Press button with more than one finger, a wrist, a whole hand or a thumb
Mouse hops or slides	• hopping movement instead of sliding movement • rolling movement • mouse hops only once

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