Clarifying the Effects of Anthropomorphism on Consumer Behaviour

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by

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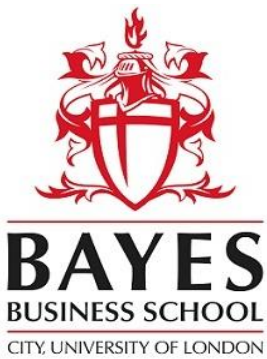

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DECLARATION

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ABSTRACT

Anthropomorphism, the endowment of humanlike traits to nonhuman entities, has become ubiquitous because it leads to desirable marketing outcomes, such as positive product evaluations and favourable brand attitudes. In the past two decades, a rapidly expanding body of research on this topic has examined how consumers relate to anthropomorphised entities. Since empirical studies often use a heterogeneous set of operationalisations, various suggestions have been provided on how to achieve a clear and precise conceptual understanding to explain how anthropomorphism influences consumer responses. However, the question of how to effectively elicit anthropomorphism and manipulate it to influence consumer responses remains unanswered.

To address these key questions, my thesis aims to systematise the effects of various anthropomorphism manipulations on the elicitation of this construct and downstream consumer responses in a comprehensive conceptual framework. More specifically, in *Chapter 2*, I categorise existing manipulations into visual and verbal, and test their efficacy on measures of perceived anthropomorphism. To this end, I consider two key dimensions of anthropomorphism often used interchangeably in existing literature, which are humanlike physical appearance and humanlike mind, as distinct from each other. I map these dimensions onto their corresponding manipulation methods and measures and highlight the independent routes through which they elicit anthropomorphism. Combining findings from three experiments and a meta-analysis, I find that visual and verbal manipulations elicit different dimensions of anthropomorphism. That is, visual manipulations heighten the perception of a humanlike physical appearance, while verbal manipulations heighten the perception of a humanlike mind.

In *Chapter 3*, I examine the downstream consequences of anthropomorphism using different manipulation methods, by systematically comparing the relative effectiveness of visual, verbal, and combined manipulations on consumer responses. Accordingly, I consider that various manipulations affect different facets of anthropomorphism, which in turn could affect consumer responses in different ways. More specifically, building on findings from the human-to-human communication and advertising literature, I expect that verbal manipulations would convey the target products' humanlike mind, leading to stronger consumer responses as compared to visual ones that convey their humanlike physical appearance. In addition, I expect that combined manipulations would elicit similar effects to verbal ones due to the visual redundancy effect. Utilising a multi-level multivariate meta-analysis, the findings provide

evidence in favour of the first prediction but not the second, as verbal manipulations dominate both visual and combined manipulations in the degree to which they affect consumer responses, while the latter two show statistically similar effects.

Overall, this thesis contributes to the literature on anthropomorphism. First, this research demonstrates the differential impact of anthropomorphism manipulations on the elicitation of anthropomorphism by examining their relationship with the key dimensions, providing clarity on this focal construct. Second, this research shows the differential impact of anthropomorphism manipulations on consumer responses, providing evidence that they affect consumers in different ways.

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Chapter 1

Introduction

Introduction

Anthropomorphism is defined as imbuing the real or imagined behaviour of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions (Epley, Waytz and Cacioppo 2007). From product design to marketing communication and customer relationship management, anthropomorphism is ubiquitous in commercial usage. Indeed, around 35% of Nielsen's top 100 grocery brands in the U.K. utilised anthropomorphic representations on their product packaging in 2010 (Triantos et al. 2016). Such representations for brand and product promotion exist in many different forms (MacInnis and Folkes 2016; Waytz, Klein and Epley 2013; Yang, Aggarwal and McGill 2020). On the one hand, some companies imbue their products or brand mascots with humanlike physical appearance (e.g., Michelin Man), to make them more appealing and emotionally connected to consumers (Gouda 2016). On the other hand, other companies imbue their products with a humanlike mind by attributing a personality or conversational style (e.g., Google's AI assistant), to entice consumers to engage with them more naturally (Newcomb 2019).

In light of its prevalence in the marketplace, the importance of anthropomorphism as an effective marketing tactic has been highlighted in numerous research articles (e.g., MacInnis and Folkes 2016; Yang et al. 2020), marketing textbooks (e.g., Aggarwal and McGill 2016; Dahl 2018; Valenzuela and Hadi 2017) and the commercial press (e.g., Forbes 2016; Walton 2015). Within consumer research, scholars have focused on understanding when and how to use anthropomorphism to influence consumers' responses by treating the target entities like humans. These responses refer to consumers' direct judgements of and behaviours towards the target objects in a consumption-based context such as product preference, brand attitude, purchase intention and usage intention.

Prior research has commonly tested anthropomorphism through the presence versus absence of humanlike features in target products and observed whether consumer responses are influenced by the presence of these features. However, the extant literature has relied on a heterogeneous set of anthropomorphism manipulations to induce product anthropomorphism, by signalling the presence of different facets of humanlike characteristics. Some studies rely on the use of visual manipulations to make products possess a humanlike physical appearance, such as the endowment of facial features or bodily figure (e.g., cars designed with smiling faces, Aggarwal and McGill 2007). Other studies utilise verbal manipulations which include verbal cues such as personal pronouns, to allow anthropomorphic entities to express their own inner voice or qualities, or directly describe a product with its own intentions, agency or goals (e.g., "I am your credit card assistant, and I know what you

need.", Puzakova, Rocereto and Kwak 2013); and verbal instructions to request that participants engage with anthropomorphic thinking of a product or brand (e.g., imagine X brand had come to life as a person, and think about its personality, appearance, or conversational style; Aggarwal and McGill 2012). Lastly, a proportion of studies employ combined manipulations, i.e., the use of both visual and verbal cues within the same stimuli, to induce product anthropomorphism (e.g., using facial features and personal pronoun together, Puzakova et al.2013).

While anthropomorphism has been interchangeably operationalised by adopting the different facets of humanlike characteristics described above, some researchers have questioned whether these heterogeneous operationalisations can accurately capture the overall construct (Epley 2018; Golossenko, Pillai and Aroean 2020; Kim and McGill 2018; Reavey et al. 2018). On the one hand, some researchers have considered anthropomorphism as a unidimensional construct (Epley 2018; Epley, Schroeder and Waytz 2013; Herak, Kervyn and Thomoson 2019; Schroeder and Epley 2016; Waytz el al.2010). For instance, Epley (2018) argues that mind perception, i.e., the inference of others' mental state, solely underlies the elicitation of anthropomorphism. In this way, the author differentiates between attributing visual features (e.g., a pair of eyes) on products and eliciting anthropomorphism through mind perception. As such, Epley (2018) suggests testing existing manipulations independently in order to assess whether they can equally elicit anthropomorphism through mind perception.

On the other hand, more recent research offers alternative suggestions on the processes underlying anthropomorphism, by considering it as a multidimensional construct that can have different manifestations (Golossenko et al. 2020; Reavey et al. 2018; Yang et al. 2020). Golossenko et al. (2020), for example, propose that anthropomorphism is defined as the perception of the target brand as an entity with both humanlike physical appearance and humanlike mind. In contrast, Yang et al. (2020) speculate on the existence of a continuum structure ordering the different dimensions of anthropomorphism, with humanlike physical appearance inducing a relatively shallow degree of anthropomorphism, and humanlike mind inducing the deepest one. Irrespective of whether these two dimensions jointly define anthropomorphism or show different intensities in eliciting this construct, the current multidimensional viewpoint implies these two dimensions are conceptually correlated.

The above viewpoints have offered different frameworks to conceptualise anthropomorphism, leaving open the question of what anthropomorphism is and how to

effectively elicit it. This in turn poses a challenge on how to precisely implement the construct of anthropomorphism and adequately explain its ability to influence consumer responses. To this end, this thesis offers a conceptual systematisation of the various anthropomorphism manipulations to assess their differential effectiveness.

More specifically, I categorise various manipulations into three broad types based on the key dimensions of anthropomorphism suggested by the stimuli. These include: visual (i.e., the use of visual features suggesting the addition of humanlike physical appearance to objects), verbal (i.e., the use of verbal information indicating that the object has a humanlike mind) and combined manipulations (i.e., the use of visual and verbal elements within the same stimuli). I then empirically evaluate their impact on two outcomes: namely, on the extent to which they effectively elicit anthropomorphism and on their ability to influence consumer responses. In the next section, I provide an overview of each chapter, outlining the key findings and contributions to the extant literature.

Objectives and Contributions

Chapter 2: The Elicitation of Anthropomorphism: Experimental Evidence and Meta-Analysis

Given that different theoretical understandings exist regarding the concept of anthropomorphism and the triggering factors eliciting it (c.f., Epley 2018; Golossenko et al. 2020; Yang et al. 2020), it remains unclear whether visual and verbal manipulations impact on the perception of anthropomorphism. Moreover, irrespective of how anthropomorphism is manipulated, scholars have used a heterogeneous set of operational definitions capturing this construct, posing a challenge to the understanding of how anthropomorphism is elicited by various manipulations. Taking these insights into consideration, the objective of *Chapter 2* is to investigate whether and how visual and verbal manipulations trigger the elicitation of anthropomorphism.

To address this key question, in Chapter 2, I build on the multidimensional viewpoint of anthropomorphism (c.f. Golossenko et al. 2020; Yang et al. 2020) and propose an alternative framework considering the possibility that the two key dimensions of anthropomorphism (i.e., humanlike physical appearance and humanlike mind) are distinct from each other. I then map these two key dimensions onto their corresponding manipulation methods and measures and argue that visual and verbal manipulations elicit anthropomorphism through distinct routes depending on the key dimensions of anthropomorphism suggested by the stimuli.

To test this, I first conducted three pre-registered experiments. Specifically, I adopted three sets of original manipulations from the literature (Huang et al. 2019; Newton et al. 2017; Puzakova, Kwak and Rocereto 2013), and created variations of those to allow for a direct comparison of the effects of visual and verbal manipulations on perceived anthropomorphism. The findings from these three studies consistently show that verbal manipulations more strongly predict the perception of a humanlike mind. Next, to systematically examine whether visual and verbal manipulations result in the perception of a humanlike physical appearance and a humanlike mind respectively, I conducted a meta-analysis. Utilising a random-effects model, I find that when controlling for the associated key dimension of anthropomorphism between their corresponding manipulation methods and assessments, visual manipulations heightened the perception of a humanlike physical appearance, while verbal manipulations heightened the perception of a humanlike mind.

Overall, my findings indicate that visual and verbal manipulations exhibit differential efficacy of eliciting anthropomorphism, depending on their conceptual distances from the dimensions of anthropomorphism they are meant to induce (i.e., humanlike physical appearance and humanlike mind respectively). Going beyond the literature that interchangeably used these manipulations to elicit anthropomorphism, I show their distinct routes which elicit different facets of anthropomorphism, thus providing further clarity on this focal construct and its relationship to its key dimensions.

Chapter 3: A Meta-Analysis on the Effects of Anthropomorphism in Influencing Consumer Behaviour

The previous chapter showcased that visual and verbal manipulations affect different facets of anthropomorphism. However, it remains unclear whether they would also affect consumer responses in different ways. While some scholars have speculated that various anthropomorphism manipulations may exhibit qualitative differences in their effectiveness in triggering anthropomorphism (Kim and McGill 2011; 2018; Reavey et al. 2018; Yang et al. 2020), few suggestions have been made as to whether these manipulations would lead to differential effects on consumer responses (i.e., consumers' direct judgements of and behaviours towards the target objects). Furthermore, scholars have acknowledged that anthropomorphism produces mixed patterns of consumer responses which could be positive (e.g., Aggarwal and McGill 2007; Chen, Wan and Levy 2016; Huang et al. 2019), negative (e.g., Kim, Chen and Zhang 2016; Puzakova et al. 2013; Puzakova and Kwak 2017), or even

not different compared to non-anthropomorphic conditions (e.g., Nelson and Simmons 2020; Williams, Masser and Sun 2015). Based on these insights, the objective of *Chapter 3* is to investigate the relative effectiveness of visual, verbal and combined manipulations in influencing consumer responses.

To this end, I build on findings from the human-to-human communication literature that vocal manipulations conveying the presence of a humanlike mind would lead to a more positive evaluation of targets, compared to visual manipulations conveying the presence of biological life. Analogously, I expect that verbal manipulations would convey the target products' humanlike mind, leading to stronger consumer responses as compared to visual ones that convey their humanlike physical appearance. In addition, findings from the human-to-human communication and advertising literature suggest that combined manipulations could elicit similar effects to verbal ones due to the visual redundancy effect. This effect indicates that adding visual information to verbal manipulations does not change ones' inference about a target's mental capacity, and could also be valid in the context of consumers' interactions with anthropomorphised products.

To evaluate this, I performed a meta-analysis and found that verbal manipulations induce the strongest effect on consumer responses, followed by visual and combined manipulations, which showed statistically similar effects. The findings corroborate the dominance of humanlike mind attribution in affecting consumer responses as speculated upon in the previous literature. In addition, the finding that combined manipulations elicit weaker consumer responses compared to verbal ones but similar to visual ones suggests a visual primacy explanation, which implies that in the presence of both visual and verbal information participants' attention is driven towards the former.

Overall, my findings suggest that various anthropomorphism manipulations trigger differential effects on consumer responses, because of the different facets of anthropomorphism attributed to target products allowing consumers to engage with them in different ways. Going beyond the existing literature, I offer novel empirical evidence on the effectiveness of various anthropomorphism manipulations in influencing consumer responses, and several theoretical and practical suggestions based on the current findings.

General Contribution

In summary, the two chapters jointly show that different anthropomorphism manipulations are associated with different facets of anthropomorphism, which can lead to

differential impacts on consumer responses. That is, visual manipulations heighten the perception of a humanlike physical appearance, resulting in a relatively weak effect on consumer responses. On the other hand, verbal manipulations heighten the perception of a humanlike mind, showing the strongest effect on consumer responses. The findings provide clarity on how anthropomorphism affects consumer responses and shed light on how to effectively implement anthropomorphism. These results open new avenues for research on the construct validity of anthropomorphism, as well as on achieving a deeper understanding of the ways consumers engage with anthropomorphised products.

Chapter 2

The Elicitation of Anthropomorphism: Experimental Evidence and Meta-Analysis

Introduction

Originating from the Greek words "anthropos" (which means "human") and "morphe" (which means "shape" or "form"), anthropomorphism entails the attribution of humanlike characteristics to real or imagined nonhuman entities (Epley et al. 2007; Epley, Waytz and Akalis 2008; Wan and Aggarwal 2015). Following this definition, researchers have operated this construct in various ways. These include presenting the target entity as alive (Aggarwal and McGill 2012; Chandler and Schwarz 2010), adding humanlike physical features to it (Aggarwal and McGill 2007; Ahn et al. 2014), attributing a mind to it (Kim and McGill 2011; Kwak et al. 2015; Puzakova et al. 2013; Puzakova and Kwak 2017), or giving it some other human properties such as a name, gender, or an individual identity (Wan 2018). Given the apparent heterogeneity, scholars have recently stressed the importance of discerning the triggering factors eliciting anthropomorphism, in order to enable researchers to precisely understand this focal construct and its impact on consumers (Epley 2018; Simmons, Nelson and Simonsohn 2021; Yang et al. 2020).

Although not universally acknowledged in the literature, several authors have proposed that the current operationalisations reflect the two key dimensions of anthropomorphism, *humanlike physical appearance* and *humanlike mind* (Aggarwal and McGill 2007; Golossenko et al. 2020; Kim and McGill 2011, 2018; Wan and Aggarwal 2015; Waytz et al. 2010; Yang et al. 2020). Specifically, humanlike physical appearance refers to observable physical features that resemble humans; while humanlike mind refers to unobservable psychological qualities that humans possess i.e., motivations, emotions, intentions or inner mental states (Epley et al. 2007, 2008; Golossenko et al. 2020; Wan and Aggarwal 2015; Waytz et al. 2010).

Until now, scholars have provided many suggestions on the elicitation of anthropomorphism: solely triggered by the perception of a humanlike mind of the target products (Epley 2018; Waytz et al. 2010); jointly triggered by the perception of humanlike physical appearance and humanlike mind (Golossenko et al. 2020; Ruijten et al. 2019); or triggered by either of these dimensions but with different intensity, from a relatively shallow degree (humanlike physical appearance) to a deeper one (humanlike mind) (Yang et al. 2020).

Given that these theoretical arguments have offered different insights on this focal construct, it remains unclear whether these two key dimensions are both necessary to elicit anthropomorphism. For example, if the apparent presence of a humanlike mind elicits the strongest perception of anthropomorphism (c.f. Yang et al. 2020), the corresponding stimuli

would be more effective than those that signal a humanlike physical appearance. Moreover, although researchers have recently proposed the multidimensional nature of anthropomorphism which can have different manifestations (c.f. Golossenko et al. 2020; Yang et al. 2020), it is unknown whether these two key dimensions can be perceived concurrently from various anthropomorphism manipulations. Lastly, prior research has used these two key dimensions of anthropomorphism interchangeably or in combination even though each dimension could occur independently of the other. However, there is scant empirical evidence evaluating the possibility that these dimensions are distinct or of what the precise associated implications for the elicitation of anthropomorphism might be.

In light of the above considerations, the current chapter proposes to disentangle the role of each key dimension and their individual impacts on the perception of anthropomorphism. In particular, in response to the calls by Epley (2018) and Yang et al. (2020) as to whether the heterogeneous set of operationalisations can equally account for the elicitation of anthropomorphism, I differentiate existing manipulations based on the key dimensions of anthropomorphism. Specifically, I differentiate between: (1) visual manipulations, i.e., the addition of humanlike physical appearance to objects, such as facial features or body figures; and (2) verbal manipulations, i.e., the indication that the object has a humanlike mind, either through the use of verbal cues such as the entity speaking in the first person, or utilising verbal instructions to guide participants to think of an entity as humanlike.

Moreover, to further discern the impact of visual and verbal manipulations on the perception of anthropomorphism, I build on the multidimensional viewpoints of anthropomorphism (c.f. Golossenko et al. 2020; Yang et al. 2020), and extend them further by considering the possibility that humanlike physical appearance and humanlike mind are distinct from each other. Specifically, in contrast to the current multidimensional viewpoint that the two key dimensions reflect the same true underlying concept that the focal construct represents, I argue that they represent different facets of it; that is, each of them produces individual effects that represent a subset of anthropomorphism. As a result, I argue that visual manipulations of anthropomorphism featuring a humanlike physical appearance would be more likely to have an impact on measures capturing the perception of humanlike physical appearance, rather than the perception of the product possessing a humanlike mind. Correspondingly, verbal manipulations of anthropomorphism indicating the presence of a humanlike mind would be more likely to have an impact on measures capturing the

perception of a humanlike mind, rather than the perception of the product possessing a humanlike physical appearance.

This chapter offers several contributions. On a theoretical level, it aims to resolve the ongoing debate on the triggering factors eliciting anthropomorphism. To achieve this, the current chapter offers a systematisation of the anthropomorphism manipulations in the literature and evaluates the possibility that the two key dimensions are distinct from each other. More specifically, by combining insights from three pre-registered experimental studies and a meta-analysis, the current chapter empirically assesses the impact of visual and verbal manipulations on eliciting the corresponding dimensions of anthropomorphism. On a practical level, this project offers suggestions to researchers and practitioners on how to enhance the efficacy of the design of anthropomorphism manipulations and measures of the construct.

Conceptual Foundations

Key Dimensions of Anthropomorphism and their Roles in Defining Anthropomorphism

Following Waytz et al. (2010), existing experimental manipulations can be mapped onto visual and verbal ones, according to the key dimensions of anthropomorphism featured in the stimuli (see *Table A1* for mapping decisions in detail). Specifically, some studies have used visual cues to attribute a humanlike physical appearance to the target products. These include the direct placement of faces on target objects (e.g., Hur et al. 2015; Tam et al. 2013), the arrangement of geometric elements to resemble a humanlike face or eyes (e.g., Huang et al. 2019; Kim and McGill 2011), the attribution of humanlike bodily figures on target objects (e.g., adding limbs: Awad and Youn 2018; Huang et al. 2019; Schneider 2019), or the portrayal of a target product possessing humanlike behaviours by rearranging visual elements (e.g., a product on a beach chair suggesting it is sunbathing using a hat, Puzakova et al. 2013). As suggested by prior research, people are sensitive to detecting cues that morphologically resemble surface-level humanlike characteristics, and they can automatically perceive this similarity even in an abstract manner (Golossenko et al. 2020; Landwehr, McGill and Hermann 2011; Maeng and Aggarwal 2018; Windhager et al. 2009). Accordingly, the presence of humanlike physical appearance requires participants to use a human schema to draw similarities between the anthropomorphised entity and humans (Aggarwal and McGill 2007; Golossenko et al. 2020; Kim and McGill 2011).

Other studies have used verbal information to indicate that a target entity possesses unobservable humanlike inner qualities. These include the use of either verbal cues or of verbal instructions. Verbal cues are personal pronouns allowing products to speak for themselves (e.g., Aggarwal and McGill 2007; Awad and Youn 2018; Hur et al. 2015; Newton et al. 2017; Touré-Tilley and McGill 2015), the description of products as if they have their own identities and personalities (e.g., "We are the Maxco Charger family! We will be trusted partners on your journey", Wan, Chen and Jin 2017), and the suggestion that target products have their own intentions, goals, and agency (e.g., "I am your credit card assistant, and I know what you need", Puzakova, Rocereto and Kwak 2013). Verbal instructions invite participants to think about target products in human terms. For example, they invite participants to consider a brand or product as coming alive as a person (e.g., Aggarwal and McGill 2012; May and Monga 2014; Zhou, Kim and Wang 2018), or ask participants to attribute humanlike traits to the target entity (e.g., Chandler 2010; Chandler and Schwarz 2010; Mourey, Olsen and Yoon 2017). The use of verbal cues and verbal instructions may provide different triggers for the perception of anthropomorphism, depending on their association to participants' processing style (Chandler 2010; Epley 2018; Yang et al. 2020). While verbal cues serve as bottom-up information elicited by the object to guide people to interpret the attribution of unobservable humanlike inner qualities in it, verbal instructions promote the top-down reasoning process conducted by participants to think about its humanlike traits such as its personality. Together, these studies relied on the presence of verbal manipulations to suggest the attribution of unobservable human inner qualities to target products, which guide participants to perceive anthropomorphism through the ascription of a humanlike mind. This involves experiencing and engaging with others' mental states (i.e., mind attribution), which can require some deliberate attention rather than being automatically perceived as in the case of humanlike physical appearance elicited by visual cues (Epley 2018; Epley and Waytz 2010; Lin, Keysar and Epley 2010).

Whereas visual and verbal manipulations trigger different facets of anthropomorphism that may require separate activation processes, a large proportion of studies has used these manipulations interchangeably, and often combined them together within the same stimuli to elicit anthropomorphism (i.e., combined manipulations: e.g., Kwak et al. 2015; Puzakova et al. 2013; Puzakova and Kwak 2017). Given this, it remains unclear what is the contribution of each key dimension of anthropomorphism in eliciting this focal construct. Furthermore, scholars have commonly considered the two dimensions as manifestations of the focal

construct, implying that they elicit anthropomorphism through the same underlying concept (c.f., Golossenko et al. 2020; Yang et al. 2020). If this assumption is true, combined manipulations would produce the same magnitude of effects on perceived anthropomorphism irrespective of how the focal construct is measured. Even in the case of assessing items that measure both the perception of humanlike physical appearance and humanlike mind, one would expect that these items would be highly correlated and capture the same underlying concept that the focal construct represents.

However, previous empirical evidence has indicated the existence of qualitative differences between the perception of humanlike physical appearance and humanlike mind. To illustrate, factor loadings[1] from the Brand Anthropomorphism Scale (BASC) showed a relatively low convergent validity between items reflecting the perception of humanlike physical appearance and humanlike mind (i.e., correlations smaller than 0.5, Golossenko et al. 2020). This indicated that when participants were faced with combined manipulations, they could distinguish items assessing humanlike physical appearance and humanlike mind from each other.

Similarly, Ruijten et al. (2019) utilised the Rasch analytical approach to combine existing individual instruments of humanlike physical appearance and humanlike mind. The authors found that when participants were faced with social robots designed with both humanlike physical appearance and humanlike mind, they could recognise that items of these two dimensions tapped into the perception of humanlike physical appearance and humanlike mind respectively. Moreover, when comparing the convergent validity of the integrated scale using both of the key dimensions to two existing scales that tap into humanlike physical appearance and humanlike mind individually, the authors found significant but low correlations between them.[2] This finding suggests a possible differentiation in perception of anthropomorphism depending on its distinct dimensions. That is, when utilising a given stimulus to elicit anthropomorphism, there may exist qualitative differences in how participants assess items that are solely measuring humanlike physical appearance or

[1] According to Golossenko et al. (2020), anthropomorphism consists of physical appearance, moral virtue, cognitive experience and conscious emotionality. The latter three fall into my categorisation of humanlike mind (i.e., I considered the latter three as subdimensions of humanlike mind). The reported correlations of humanlike physical appearance and the dimensions of humanlike mind are 0.35, 0.49, 0.49 respectively.

[2] Specifically, results indicated a significant but low correlation between the proposed scale (that assessed both perceived humanlike physical appearance and humanlike mind) and Godspeed instrument (that only assessed the perception of humanlike physical appearance), $r = .22$, $p = .01$. In addition, the authors found a significant but low correlation between the proposed scale and IDAQ scale (that only assesses the attribution of humanlike mind), $r = .46$, $p < .001$. The findings were also robust after correcting for measurement error attenuation (i.e., showed correlation of .30 and .59 to measurement instruments that solely assessed perceived humanlike physical appearance and humanlike mind respectively).

humanlike mind or their combination. To this end, I suggest considering that each of these dimensions may represent different defining characteristics that underlie the focal construct of anthropomorphism.

Differences in the Induction of Anthropomorphism

Given the possibility that anthropomorphism can occur through different routes depending on the facets represented by its key dimensions, it is important to consider how to specify measures to adequately capture the elicitation of the focal construct.

Within consumer research, there are three main ways to assess the perception of anthropomorphism. First, the majority of studies relied on manipulation check items that are solely assessing the perception of humanlike mind in target products from the given stimuli (e.g., Kim and McGill 2011; May and Monga 2014; Puzakova and Kwak 2017; Zhou et al. 2018). These studies adapted the Individual Differences in Anthropomorphism Questionnaire (i.e., IDAQ scale, Waytz et al. 2010), which assesses the extent to which people consider certain nonhuman agents as human and attribute humanlike mental states to them (i.e., the extent to which a non-human entity has 'a mind of its own', 'intentions', 'a free will', 'consciousness' and 'the capacity to experience emotions'). Second, other studies relied on measurement items that are solely assessing the perception of humanlike physical appearance (e.g., asking whether a product looks like a person/human, Aggarwal and McGill 2007; Hudson et al. 2016; Kim and McGill 2011; Kim et al. 2016; Newton et al. 2017; Williams et al. 2015). Third, a small proportion of studies have used a combination of measurement items in the same instrument, assessing the perception of humanlike physical appearance and humanlike mind at the same time (Awad and Youn 2018; Kim, Chen and Zhang 2016; Kim and McGill 2011; Newton et al. 2017). Despite their rare use in the literature, other developed scales have combined items that capture both the perception of a humanlike physical appearance and a humanlike mind within the same measurement instrument. These include the brand anthropomorphism scale (BASC, Golossenko et al. 2020), measures of brand anthropomorphism (Guido and Peluso 2015) and the anthropomorphism scale (Ruijten et al. 2019).

Hence, to the extent that each key dimension is distinct and represents different facets of anthropomorphism, its elicitation by the corresponding manipulation should be more readily captured by the measures that relate to it. More specifically, I suggest that visual manipulations signalling the humanlike physical appearance of target products should have a

stronger impact on measures capturing the perception of humanlike physical appearance, compared to those capturing the perception of a product possessing a humanlike mind. Correspondingly, verbal manipulations featuring target products possessing a humanlike mind should have a stronger impact on measures capturing the perception of a humanlike mind, compared to those capturing the perception of a product possessing a humanlike physical appearance.

Need for Further Investigation

There are several reasons to examine the possible distinction between the two dimensions of anthropomorphism, and their association to anthropomorphism manipulations uniquely captured by their measures. First, I argue that each dimension is sufficient to elicit anthropomorphism, without necessarily leading people to perceive the other one. For instance, ascribing a pair of eyes to a juice bottle (i.e., visual manipulations) does not necessarily lead people to believe that the bottle can think and feel (i.e., perception of a humanlike mind), but it can elicit anthropomorphism when the human schema process is activated by participants. Therefore, the perception of a humanlike physical appearance induced by visual manipulations may be enough to render an entity congruent with human schema and change the way it is perceived. In contrast, asking participants to think of a brand's own intention (i.e., verbal manipulations) does not necessarily lead people to think of its bodily figures (i.e., perception of humanlike physical appearance), but anthropomorphisation could occur when the mind attribution process is activated. Hence, the perception of a humanlike mind induced by verbal manipulations could trigger anthropomorphism without the perception of a humanlike physical appearance. If this argument is supported, neglecting the distinction between the two dimensions by not matching the manipulations with their corresponding measures could lead to underestimating the focal effect.

Second, although recently developed scales have combined humanlike physical appearance and humanlike mind items (c.f., Golossenko et al. 2020; Ruijten et al. 2019), they exhibited low correlations between them, indicating the qualitative differences between the two dimensions. Moreover, since these scales have relied on using combined manipulations to refine and validate the items of perceived anthropomorphism, it is unclear whether they would still precisely reflect different facets of anthropomorphism when used solely with visual or verbal manipulations. It is possible that visual and verbal elements from combined

manipulations in these studies exhibit a unique impact on eliciting anthropomorphism, and jointly show additive effects on the perception of anthropomorphism. As a result, anthropomorphism may be perceived differently when participants are exposed to visual and verbal cues in isolation. Thus, if the elicitation of a humanlike physical appearance and humanlike mind is entangled with anthropomorphism manipulations and measures, independently evaluating each of these dimensions can provide clarity on how consumers perceive anthropomorphism, and what are its triggering factors.

To gain further understanding on the distinct impact of each dimension on the elicitation of anthropomorphism, I conducted three experimental studies and a meta-analysis. Adopting the most commonly used measurement items of perceived anthropomorphism from the extant literature that mainly focused on humanlike mind items, the three pre-registered experimental studies (N = 1,109) aimed to assess whether different manipulation methods (i.e., visual and verbal) elicited anthropomorphism in distinct ways. Furthermore, I conducted a meta-analysis of 108 effects (N = 15,604), to gain a comprehensive overview of the effects of visual and verbal manipulations in eliciting key dimensions of anthropomorphism. Namely, whether visual and verbal manipulations lead to greater impact on the respective measurement items reflecting the same dimension of anthropomorphism.

Method

Studies 1-3: Experimental Studies

Overview of Experimental Studies

In Studies 1 and 2, I examined the effects of visual and verbal manipulations on perceived anthropomorphism by adapting original manipulations from Puzakova, Kwak and Rocereto (2013: Study 2B) and Newton et al. (2017: Study 1), respectively. Specifically, I used two conditions from the original papers (i.e., anthropomorphic condition and control condition), and created two additional conditions by isolating the visual and verbal elements of the original manipulations to disentangle their effects on perceived anthropomorphism. The measurement items used to assess anthropomorphism in both of my studies came from the original studies. They were combined with other items designed to assess the perceived humanlike mind of the target entity, which is the most common approach to measure perceived anthropomorphism in the literature. Furthermore, in Study 2, given that a single item from the original studies captured the perception of humanlike physical appearance, I

examined the impact of visual and verbal manipulations separately on the items measuring humanlike physical appearance and humanlike mind respectively.

Since the first two studies focused on differentiating the effects of visual and verbal manipulations on perceived anthropomorphism, they did not provide indications on the effects of different types of verbal manipulations on perceived humanlike mind (i.e., verbal cues vs. verbal instructions). To address this, in Study 3, I adapted another set of stimuli that originally combined visual elements, verbal cues and verbal instructions of a target product (i.e., Huang et al. 2019: Study 1B), and isolated each of their individual effects on promoting humanlike mind.

Study 1

Study 1 was pre-registered on AsPredicted (#14294), where I hypothesised that the verbal manipulations promote the perception of a humanlike mind. As a result, verbal manipulations would exhibit a stronger impact on measures capturing the perception of a humanlike mind, compared to visual manipulations that elicit the perception of humanlike physical appearance.

Data Collection and Participants

Since the study was an extension of an existing design, I followed the suggestion to recruit 2.5 times the original sample size and set a minimum of a hundred participants per condition (Nelson, Simmons and Simonsohn 2018; Simonsohn 2015). The study was conducted on Prolific.ac. Participants were restricted to residents of the United States and Canada. To ensure the quality of observations, I set up the criteria of at least 95% and above approval rate; as well as at least one previous submission on Prolific.ac so that participants had a basic understanding of the platform. Finally, since the original manipulation involved verbal elements, I also pre-screened for participants' language ability (e.g., no language disorder). Participants received monetary compensation in exchange for completing the study (i.e., £0.34 per participant).

Design, Stimuli and Procedure

Four hundred and one participants located in the United States and Canada were recruited via Prolific.ac (50.1% female, M_{age} = 35.00, SD_{age} = 11.60). The study was a 2 (visual manipulation: present vs. absent) by 2 (verbal manipulation: present vs. absent)

between-subjects design ($N_{\text{visual present+verbal present}} = 100$, $N_{\text{visual present+verbal absent}} = 101$, $N_{\text{visual absent+verbal present}} = 100$, $N_{\text{visual abesent+verbal absent}} = 100$). Participants read a product advertisement for a steam iron and answered questions related to it.

In the visual manipulation present condition, the steam iron's features resembled a face (i.e., a pair of eyes was added), whereas in the visual manipulation absent condition, the steam iron lacked this feature. In contrast, in the verbal manipulation present condition, the steam iron spoke using a first-person pronoun in the advertisement ("I"), whereas in the verbal manipulation absent condition, it was presented in impersonal language ("It"). In addition, to control for potential confounds from the original manipulation, I removed the friendly tone of voice from the stimuli (e.g., from "Hey, my name is Zelt!" to "I am Zelt."), to better isolate the effect of anthropomorphism from that of the tone of voice of the anthropomorphised agent.

After examining the stimuli, participants reported the extent to which they perceived the product as anthropomorphised through the perception of a humanlike mind using nine 7-point items ($\alpha = .951$). In accordance with the design of Puzakova et al. (2013) assessing the perception of anthropomorphism solely based on humanlike mind, I included the following original items: the extent to which participants perceive the product has its own beliefs and desires, has consciousness, has a mind of its own. Additionally, I included other measures of perception of a humanlike mind suggested by prior research (Hur et al. 2015; Newton et al. 2017; Waytz et al. 2010) that measured the extent to which participants perceive that the product has the ability to come alive like a human, can experience emotions, has free will, has its own intentions, knows what it wants, and reminds participants of some humanlike qualities (1 = "Strongly disagree", and 7 = "Strongly agree"). Next, participants were asked to answer an open-ended question regarding the purpose of the study in order to ensure that demand effect was not a concern in this study. The answers confirmed that this was not the case. At the end of the survey, participants were required to provide their demographic background including age, gender, and education.

Results

Results from a two-way ANOVA on perceived humanlike mind revealed a significant main effect of verbal manipulations ($M_{\text{verbal present}} = 2.77$, $SD_{\text{verbal present}} = 1.49$, $M_{\text{verbal absent}} = 1.63$, $SD_{\text{verbal absent}} = .92$, $F(1, 397) = 84.96$, $p < .001$, $\eta^2 = .176$), but not of visual manipulations ($M_{\text{visual present}} = 2.25$, $SD_{\text{visual present}} = 1.45$, $M_{\text{visual absent}} = 2.15$, $SD_{\text{visual absent}} =$

1.27, $F(1, 397) = .606$, $p = .437$, $\eta^2 = .002$). The interaction effect of visual and verbal manipulations was not statistically significant ($F(1, 397) = .438$, $p = .508$, $\eta^2 = .001$), indicating that the interaction of visual and verbal elements does not lead to the perception of a humanlike mind. Overall, these findings revealed that only verbal manipulations fostered the perception of a humanlike mind, whereas visual ones did not.

One concern about Study 1 might be that participants might have had difficulty discerning the visual manipulations (i.e., the eyes on the steam iron) because these were more subtle than the explicit verbal instructions. To rule out this explanation, I conducted a post-test with 172 students from a university subject pool recruited to participate in an online study (77.3% female, $M_{age} = 22.40$, $SD_{age} = 1.99$). I adopted two conditions from the same design (i.e., testing the presence vs. absence of visual manipulation, while keeping verbal manipulation absent), and asked participants to report the extent to which they could see a face on the steam iron and whether the iron looked like having a face on 7-point scales ($\alpha = .936$). There was a significant difference on the salience of the visual features between the two conditions ($M_{visual\ presence} = 5.19$, $SD_{visual\ presence} = 1.53$, $M_{visual\ absence} = 2.12$, $SD_{visual\ absence} = 1.31$, $p < .001$), which showed that participants noticed the anthropomorphised visual manipulation. These results suggest that the lack of effect of the visual manipulation observed in the main study was not due to its subtlety, but instead due to the fact that the visual manipulation is not sufficient to trigger the perception of a humanlike mind of a target product.

Study 2

Study 2 replicated the approach of Study 1, using a different target entity (i.e., a digestive system instead of a steam iron), with the aim of generalising insights on the elicitation of anthropomorphism triggered by visual and verbal manipulations respectively. The study was pre-registered on AsPredicted (#14441), where I expected the same pattern of results as in Study 1, i.e., that verbal manipulations would have a stronger impact on measures capturing humanlike mind compared to visual manipulations. Moreover, since this study included the item measuring humanlike physical appearance, I expected that visual manipulations would have a stronger impact on this item compared to verbal ones.

Data Collection and Participants

Applying the same data collection criteria as in Study 1, I set up the same sample size and participant pre-screening standards. Participants received monetary compensation in exchange for completing the study (i.e., £0.34 per participant).

Design, Stimuli and Procedure

Four hundred participants located in the United States and Canada were recruited via Prolific.ac (45.8% female, M_{age} = 34.00, SD_{age} = 11.25) for a 2 (visual manipulation: present vs. absent) by 2 (verbal manipulation: present vs. absent) between-subjects design ($N_{visual\ present+verbal\ present}$ = 98, $N_{visual\ present+verbal\ absent}$ = 96, $N_{visual\ absent+verbal\ present}$ = 102, $N_{visual\ abesent+verbal\ absent}$ = 104). Participants read an advertisement promoting healthy behaviour displaying a digestive system and answered questions related to it. In the visual manipulation present condition, the digestive system featured humanlike facial features (i.e., a pair of eyes and a mouth); whereas in the visual manipulation absent condition, the digestive system lacked these features. In the verbal manipulation present condition, the digestive system spoke in first-person pronoun in the advertisement ("I"); whereas in the verbal manipulation absent condition, it was presented in impersonal language ("It"). In addition, to isolate the effect of anthropomorphic cues from that of emotional display, the sad facial expression in the original manipulation was changed into a neutral facial expression.

After being exposed to the stimuli, participants reported the extent to which they perceived the digestive system as anthropomorphised using twelve 7-point items (α = .951). I included the six manipulation check items from the original study that measured perception of anthropomorphism (Newton et al. 2017), of which one assessed the perception of humanlike physical appearance, and the other five assessed the perception of humanlike mind. That is, the items assessed the extent to which participants perceived that the digestive system: looks like a person (i.e., perception of humanlike physical appearance); seems to have emotions and feelings, knows what it wants, has free will, seems to have the capacity to judge one's actions and has its own intentions (i.e., perception of humanlike mind). Moreover, as suggested by Newton et al. (2017), since anthropomorphising a digestive system that is a body part of participants can lead them to consider it as non-independent and part of the self, I adopted two more items of perceived humanlike mind located in post-test of the original study, to gain further insights on whether participants considered the anthropomorphised digestive system as distinct to themselves. These two additional items

captured the extent to which participants perceived that the digestive system has its own identity and has certain expectations about what one's behaviours should be like. Lastly, to ensure results comparable to Study 1, I included the four measures of perception of humanlike mind adopted in Study 1 (Hur et al. 2015; Newton et al. 2017; Waytz et al. 2010), that measured the extent to which participants perceived that the digestive system: has its own beliefs and desires, has consciousness, has a mind of its own, and reminds participants of some humanlike qualities (1 = "Strongly disagree", and 7 = "Strongly agree").

To ensure that the modification of visual elements from sad to neutral did not result in changes in emotionality, I used an additional question to assess the perceived emotionality of the poster. Participants were asked to choose one of the emotional tones that the poster displayed, adapted from the six basic emotions that people normally perceive from facial expression (i.e., "happiness, surprise, fear, sadness, anger and disgust"; Ekman 1992; Ekman, Friesen and Ellsworth 1972). Since I changed the original facial expression from sadness into neutral visual display, I added two additional items for participants to indicate their perceived emotional display (i.e., "no emotion at all" and "other, please specify"). After this measure, an open-ended question asked participants to leave their comments. At the end of the survey, participants were asked to provide their demographic background including age, gender and education.

Results

As noted above, the measures of perceived anthropomorphism consisted of a single item of perceived humanlike physical appearance and the rest assessed perceived humanlike mind, thus providing the opportunity to gain insights of their elicitation processes separately.

Similar to Study 1, I composed the construct of perceived humanlike mind based on the eleven items assessing this dimension of anthropomorphism ($\alpha = .946$). The results of a two-way ANOVA on perceived humanlike mind revealed a significant main effect of the verbal manipulation ($M_{\text{verbal present}} = 4.70$, $SD_{\text{verbal present}} = 1.37$, $M_{\text{verbal absent}} = 3.53$, $SD_{\text{verbal absent}} = 1.68$, $F(1, 396) = 57.81$, $p < .001$, $\eta^2 = .127$), and a significant main effect of the visual manipulation ($M_{\text{visual present}} = 4.30$, $SD_{\text{visual present}} = 1.52$, $M_{\text{visual absent}} = 3.94$, $SD_{\text{visual absent}} = 1.73$, $F(1, 396) = 5.40$, $p = .021$, $\eta^2 = .013$). The interaction effect was not significant ($F(1, 396) = .006$, $p = .939$, $\eta^2 = .000$). The findings indicated that both the visual and verbal manipulations fostered the perception of a humanlike mind. However, when comparing the effect sizes of the two main effects, it can be observed that verbal manipulations facilitated a

stronger relationship with items assessing the perception of a humanlike mind compared to visual manipulations. This result was robust to the inclusion/exclusion of the two items that measured humanlike mind but assessed whether participants considered the anthropomorphised digestive system as distinct from themselves.

Next, I tested the effects of visual and verbal manipulations on the single item of perceived humanlike physical appearance. Results from a two-way ANOVA on perceived physical appearance revealed a significant main effect of visual manipulations ($M_{\text{visual present}}$ = 3.70, $SD_{\text{visual present}}$ = 1.80, $M_{\text{visual absent}}$ = 2.28, $SD_{\text{visual absent}}$ = 1.58, $F(1, 397) = 69.70$, $p < .001$, $\eta^2 = .150$), but not of verbal manipulations ($M_{\text{verbal present}}$ = 3.00, $SD_{\text{verbal present}}$ = 1.78, $M_{\text{verbal absent}}$ = 2.94, $SD_{\text{verbal absent}}$ = 1.88, $F(1, 397) = .107$, $p = .744$, $\eta^2 < .001$). The interaction effect of visual and verbal manipulations was not statistically significant ($F(1, 397) = .753$, $p = .386$, $\eta^2 = .002$). These findings revealed that only visual manipulations fostered the perception of a humanlike physical appearance, but not verbal ones.

Lastly, to confirm that the change of visual manipulation from sad to neutral resulted in participants not perceiving emotionality of the stimuli that could confound the perception of anthropomorphism, I conduced a chi-square analysis on the measure of perceived emotionality of the poster. The result showed that participants in the visual present conditions were equally likely to perceive the stimuli as displaying emotions or not compared to those in the visual absent conditions ($\chi^2(1, N = 400) = 1.65$, $p = .199$).

Study 3

While the first two studies provided insights on the impact of visual and verbal manipulations eliciting anthropomorphism, they did not consider the fact that different verbal manipulations may provide different triggers for the perception of anthropomorphism (Chandler 2010; Epley 2018; Yang et al. 2020). To address this, in Study 3, I extended my comparison between visual and verbal cues as well as verbal instructions.

Study 3 was pre-registered on AsPredicted (#30760) and was conducted in the lab over the period of one week. Similar to the previous two studies, I expected that the verbal manipulations would promote the perception of a humanlike mind. As a result, verbal manipulations would exhibit a stronger impact on measures capturing the perception of a humanlike mind, compared to visual manipulations that induce the elicitation of humanlike physical appearance. Furthermore, this study additionally compared the effect of verbal cues and verbal instructions. Given that there is no clear indication comparing verbal cues and

verbal instructions, I formulated competing predictions in my pre-registration. On the one hand, since verbal cues and verbal instructions are conceptually relevant to eliciting the perception of humanlike mind, I expected them to show similar results on perceived humanlike items. On the other hand, given that verbal cues that directly attributed a mind to target products may be more closely related to the perception of humanlike mind compared to verbal instructions that require participants to engage with the humanlike mind of targets, one might argue that verbal instructions would yield a weaker effect on the perception of humanlike mind items, compared to verbal cues.

Data Collection and Participants

Three hundred and eight participants from undergraduate and postgraduate courses were recruited from a university subject pool in exchange for course credit (42.3% female, M_{age} = 19.46, SD_{age} = 1.70). Participants were asked to evaluate a product advertisement for a digital camera and to answer questions related to the assessment of perceived anthropomorphism.

Design, Stimuli and Procedure

I extended the original manipulations from Huang et al. (2019), which combined visual elements, verbal cues and verbal instructions of a digital camera within the same stimuli, by isolating each of their individual effects on promoting the perception of a humanlike mind. Study 3 employed a one-way between-subjects design with four conditions (N_{visual} = 78, $N_{verbal\ cues}$ = 77, $N_{verbal\ instructions}$ = 77, $N_{non\text{-}anthropomorphic}$ = 76). In the anthropomorphic visual manipulation condition, the camera had humanlike facial and body features. In the anthropomorphic verbal cues condition, the camera described its features using a first-person pronoun. In the anthropomorphic verbal instructions condition, participants were instructed to think about the camera as a person who comes to life and was introducing him/herself to them. In the non-anthropomorphic control condition, participants were asked to think about the features of the camera and evaluate its functionality.

After being exposed to the stimuli, participants reported the extent to which they perceived the product as anthropomorphised through the perception of a humanlike mind using ten 7-point items (α = .778). Since the manipulation check measures of perceived anthropomorphism from the original study focused only on assessing a humanlike mind, I included the following original items: the extent to which participants perceive that the

product sounds like a person, has free will, and has its own intentions. Similar to Studies 1 and 2, I included other measures of perception of a humanlike mind suggested by prior research (Hur et al. 2015; Newton et al. 2017; Waytz et al. 2010) that measured the extent to which participants perceive that the product: has its own beliefs and desires, has consciousness, has a mind of its own, can express emotions, knows what it wants, has the ability to come alive like a human and reminds participants of some humanlike qualities (1 = "Strongly disagree", and 7 = "Strongly agree"). Next, participants were required to provide their demographic background including age, gender and education. At the end of the survey, participants were asked to answer an open-ended question regarding the purpose of the study.

Results

The results of a one-way ANOVA revealed a significant difference between conditions on perceived humanlike mind (M_{visual} = 2.76, SD_{visual} = 1.27; $M_{\text{verbal cues}}$ = 3.50, $SD_{\text{verbal cues}}$ = 1.75; $M_{\text{verbal instructions}}$ = 3.25, $SD_{\text{verbal instructions}}$ = 1.28; $M_{\text{non-anthropomorphic}}$ = 2.84, $SD_{\text{non-anthropomorphic}}$ = 1.36, $F(3, 304) = 4.69$, $p = .003$, $\eta^2 = .044$). In support of my prediction, findings of planned contrast showed that verbal manipulations had a stronger effect on the perception of humanlike mind compared to the visual manipulation ($t(304) = 3.13$, $p = .002$). Moreover, consistent with Studies 1 and 2, verbal cues had a stronger effect on perceived humanlike mind than the visual manipulation ($t(304) = 3.26$, $p = .001$). Furthermore, verbal cues did not differ from verbal instructions ($p = .683$), but they elicited significantly higher perception of a humanlike mind compared to the non-anthropomorphic condition ($p = .021$).

In addition, post-hoc analysis revealed that there was no significant difference between verbal instructions and visual manipulations ($p = .141$), nor between verbal instructions and the non-anthropomorphic condition ($p = .283$). Lastly, there was no significant difference between the visual manipulation and the non-anthropomorphic condition ($p = .985$). Hence, the findings indicated that the perception of a humanlike mind of the camera was elicited by verbal cues, but not by the visual manipulation or verbal instructions.

Discussion

Studies 1-3 empirically assessed the effect of visual and verbal manipulations on perceived anthropomorphism, by mainly focusing on items measuring the perception of a humanlike mind. In Study 1, verbal manipulations elicited the perception of a humanlike

mind, but visual ones did not. In Study 2, I analysed the effects of visual and verbal manipulations on humanlike mind items and found that they can both elicit the perception of a humanlike mind. However, they had a differential impact as revealed by the magnitude of effect size, indicating a stronger relationship of verbal manipulations with items assessing the perception of humanlike mind, compared to visual manipulations. Moreover, given the fact that the original manipulation check measures included a single item measuring the perception of a humanlike physical appearance, I conducted additional analysis on this single item. The findings revealed that only visual manipulations fostered the perception of a humanlike physical appearance, but not verbal manipulations. Given these findings, it is possible that participants in visual manipulations considered that the targets 'look like a person' which in turn anchored their score in the rest of the items of humanlike mind, explaining the weak effect of visual manipulations on humanlike mind measures.

Study 3 showed that the dominant effect of verbal manipulations on perceiving the humanlike mind of a target product was driven by the use of verbal cues, but not by verbal instructions. In addition, visual manipulations did not have an effect on perceiving the humanlike mind of a target product.

Together, these studies consistently showed that verbal cues (versus visual manipulations) act as the dominant factor triggering the perception of a humanlike mind across various target entities (i.e., product, internal system of participants and technological device), as I expected. On the other hand, the result of the single item of humanlike physical appearance indicated that visual manipulations act as the dominant factor triggering the perception of physical appearance. However, only Study 2 tested this effect, which warrants further investigation. In view of that I conducted a meta-analysis to systematically examine whether visual and verbal manipulations facilitate the perception of humanlike physical appearance and humanlike mind respectively.

Meta-Analysis

Method

Data Collection

Studies examining the effects of anthropomorphism manipulations on perceived anthropomorphism were located via PsycINFO, Business Source Complete, and ProQuest Dissertations and Theses Global, with search terms "anthropomorphism", "humanising", and "perceived anthropomorphism". I searched and retrieved data from databases between March

2020 and April 2020. The literature retrieved was in various formats of publications, including: journal articles, book chapters, conference proceedings, and dissertations/theses. In addition, I used the same search terms to search for conference proceedings from online databases, including the Association of Consumer Research and the Society of Consumer Psychology. Furthermore, I looked for additional references in the reference lists of the core journal articles included.

Regarding data collection on unpublished work, I called for unpublished studies (e.g., working manuscripts, dissertation chapters, and conference posters) on the effects of anthropomorphism on consumer behaviour through electronic mailing lists. For the purposes of this study, I also requested available data on the effects of anthropomorphism on its manipulation check measures. The data collection request on unpublished work was posted through several electronic mailing lists, including: Electronic Marketing List Information, The Society for Personality and Social Psychology, The Society for Judgement and Decision Making, and The Association for Consumer Research (April and June 2019). Lastly, I included two studies posted on open-source websites (i.e., replication archives, Nelson and Simmons 2020).

Inclusion Criteria

The meta-analytic approach requires a set of comparable research questions and designs (Cooper et al. 2009; Scheibehenne, Greifeneder and Todd 2010). Therefore, studies were included if they examined the effects of visual, verbal, or combined manipulations on the perception of anthropomorphism (typically presented in pilot studies or as manipulation check measures in the main experiment). Specifically, I focused on collecting data from experimental studies where participants in the treatment group were exposed to an anthropomorphised target entity in a consumer context, while those in the control group were exposed to the same target entity without anthropomorphic cues.

In the search, I set the following exclusion criteria: first, studies utilising correlational or qualitative designs were not included (e.g., Kwak et al. 2015; Triantos et al. 2012; Waytz et al. 2010). Second, studies that lacked a non-anthropomorphic control condition were also excluded (e.g., Landwehr et al. 2011; Maeng and Aggarwal 2018; Yuan 2015; Yuan and Dennis 2019). Third, studies that utilised a human in the control condition rather than the non-anthropomorphised entity were excluded, because these effects may not directly inform the efficacy of anthropomorphism manipulations of target entities (e.g., Touré-Tillery and

McGill 2015). Studies which did not report manipulation check results, or did not provide enough data to calculate effect sizes were excluded (those that only reported means but no standard deviations, or lacking report of *F*/*t* values, e.g., De Bondt et al. 2018; Delbaere et al. 2011). To gather missing data from the collected published results, ten emails were sent to primary authors inquiring for additional results, of which three responses were received and the corresponding studies were added to the dataset.

As can be seen in *Figure A1*, the database search and other sources returned 1,245 papers, of which 725 were duplicates. From the remaining 520 papers, only 85 examined the effects of visual, verbal or combined manipulations on perceived anthropomorphism as discussed above. I then applied the exclusion criteria which removed 42 papers, so the final dataset contained 43 papers.

Overview of Analysed Studies

The final dataset included 108 independent effects, published or unpublished, from the period 2007 to 2020, including 37 journal articles, four PhD theses and two unpublished pre-registration replication studies (total N = 15,604). Experiments were conducted either in laboratories or online across different countries, including the United States, Canada, the United Kingdom, China (Mainland and Hong Kong) and South Korea. The target stimuli covered a wide range of goods, including products, brands, and other entities (e.g., digital assistants, social causes, body parts, time, money, nature, and agricultural produce).

Specifically, data were extracted from experimental studies that elicited anthropomorphism through the presence of visual (k = 18), verbal (k = 41), or combined manipulations (k = 49) of the same target entity and compared their effects to a control condition without anthropomorphism. Moreover, within verbal manipulations, the extracted experimental studies exhibited three forms, including verbal cues (k= 19), verbal instructions (k= 19) or a combination of the two in the same stimuli (k= 3).

Regarding the dependent variable of interest, among all collected measures of perceived anthropomorphism, the majority assessed the perception of a humanlike mind (k = 89), followed by studies that only assessed humanlike physical appearance (k = 14) and those that assessed humanlike physical appearance and humanlike mind together (k = 5).

Effect Size Measures

I used Cohen's d, or the standardised mean difference of participants' responses in the experimental versus control condition to assess the effect size. Since it is standardised,

Cohen's *d* can be used to compare the results from different studies. A positive Cohen's *d* indicates that the experimental condition induces greater perceived anthropomorphism than the control condition.

Within the dataset only a few studies specified the number of participants for treatment and control conditions separately (i.e., Nelson and Simmons 2020; Tam et al. 2013). Hence, to compute the effect sizes, I assumed for all other studies that there was an equal chance for participants to be allocated to either of the two conditions due to experimental randomisation (i.e., I divided the sample size by the number of conditions; in case of odd numbers of total participants, I rounded up the number in the treatment condition). In the dataset, there were 46 studies reporting the means and standard deviations of participants' responses in the anthropomorphised and control conditions, which I used to calculate Cohen's *d*. Fifty-nine studies provided results from either *F*-test or *t*-test, in which case I transformed these test statistics into Cohen's *d*. Three studies reported success rates of the manipulation, from which I calculated the Log Odds Ratio, and transformed this measure into Cohen's *d*.

Variable Coding

1) Type of Manipulation

As noted previously, manipulations of anthropomorphism can be mapped onto two broad types (i.e., visual and verbal manipulations), depending on which key dimension of anthropomorphism is elicited. Specifically, studies that only used visual manipulations were categorised as 'Visual' (k = 18). Studies that solely applied verbal manipulations were categorised as 'Verbal' (k = 41). In addition, I categorised studies manipulating anthropomorphism with both visual and verbal information within the same condition as 'Combination' (k = 49) as they represented a large proportion of my sample.

Moreover, similar to the rationale used in the design of Study 3, I decomposed verbal manipulations into two subgroups (i.e., verbal cues and verbal instructions) to further examine differences in their effects on perceived anthropomorphism. In particular, studies relying on cues describing an entity's humanlike mind, including personal pronouns, human names, identity, or agency, were coded as 'Verbal cues' (k= 19). In contrast, studies utilising instructions asking participants to imagine the target stimulus has come alive and to think about it as having a human personality or appearance were coded as 'Verbal instructions' (k= 19).

2) IV-DV Matching

To test whether visual and verbal manipulations would lead to elicitation of humanlike physical appearance and humanlike mind respectively, I created a variable to distinguish different measures of perceived anthropomorphism. More specifically, I coded studies using measurement items purely assessing the humanlike look and physical features of the target entity as 'Humanlike physical appearance' (k = 14). In contrast, I coded studies using items assessing that the target entity possessed unobservable humanlike qualities, i.e., mind attribution, as 'Humanlike mind' (k = 89). Studies assessing both perceived humanlike physical appearance and humanlike mind of the target entity were coded as 'Humanlike physical appearance and Humanlike mind' (k = 5).

I then created a binary variable as my focal moderator, called 'Matching'. This dummy variable assumed the value '1' if in a given study manipulation and assessment focused on the same dimension of anthropomorphism (k = 44), and '0' if not (k = 64). Specifically, the matching variable was coded as '1' if studies: used visual manipulations and measured humanlike physical appearance at the same time; or used verbal manipulations and measured humanlike mind at the same time; or used combined manipulations and assessed both humanlike physical appearance and humanlike mind at the same time.

Based on my argument, if humanlike physical appearance and humanlike mind are distinct from each other, studies with this matching variable would show stronger effects than those with no matching, as the manipulations would tap into their corresponding dimensions as captured by matching measurement items.

3) Measurement Items: Subjective versus Objective

The anthropomorphism literature suggests that participants treat an anthropomorphised target entity as partially human; that is, as less human than a person, but as more human than a non-anthropomorphised object (Aggarwal and McGill 2007; Guthrie 1993; Touré-Tillery and McGill 2015). Some measurement items reflect this partial humanness in their question framing or anchors (e.g., "it seems almost as if the product has a mind of its own"; Huang et al. 2019; Puzakova et al. 2013), while other items use question framing or anchors measuring whether the product was seen 'literally' as a human/person (e.g., "the slot machine has free will", "the backpack has feelings"; Riva, Sacchi and Brambilla 2015; Wan 2018).

In order to understand whether the framing of measurement items would affect the effect size of anthropomorphism manipulations on perceived anthropomorphism, I coded this factor as a potential moderator. Specifically, studies using measurement items featuring absolute statements, for example about the extent to which the target entity is 'literally' a human/person, were coded as 'Objective' (k = 13). In contrast, studies using measurement items featuring perceptions of partial humanness of target entities were coded as 'Subjective' (k = 72). Lastly, studies that combined objective and subjective measurement items were coded as 'Objective and Subjective' (k = 23).

I expected that the subjective framing would have a stronger impact on the overall effect size, compared to the objective framing. This is because the items stated subjectively can more accurately reflect the partial humanness of the anthropomorphised entities attributed by consumers. As a result, I expected participants would be more likely to agree on subjective items (in contrast to those objective measures that can be easily falsified), yielding greater effect sizes.

4) Assessment Technique: Manipulation Check versus Pre-test

In studies included in the meta-analysis, perceived anthropomorphism has been assessed either as manipulation check measures or in the context of pre-test studies. Specifically, studies that measured perceived anthropomorphism as manipulation checks were coded as 'Manipulation check' (k = 79). In contrast, studies that validated the effectiveness of anthropomorphism manipulations separately from hypothesis testing were coded as 'Pre-test' (k = 29). I included this moderating variable to understand whether assessing perceived anthropomorphism on a manipulation check versus on a pre-test affected the overall estimated effect size.

I expected this moderator would impact the overall effect size, because pre-test effects are associated with different stages of study refinement (Ejelöv and Luke 2020). Statistically speaking, I considered pre-test studies as confirmatory tests, because they were purposefully designed to detect the effectiveness of anthropomorphic treatments and were usually conducted before data collection. Hence, I expected that pre-test studies would yield greater effect sizes, compared to studies in the manipulation check categories.

5) Type of Design: One-way versus Interaction Design

I also coded a moderating variable reflecting whether the elicitation of perceived anthropomorphism was achieved through single or multiple manipulation procedures. Specifically, I considered studies that only manipulated anthropomorphism as 'One-way design' (k = 72), and the ones that utilised both anthropomorphism and other manipulations as 'Interaction design' (k = 36).

I expected that studies with one-way design would yield on average higher effect sizes compared to those with interaction design. This is because, in cases of multiple manipulations (i.e., 'Interaction design'), participants' attention would be diverted away from the anthropomorphism manipulation by the need to also consider the additional non-anthropomorphism manipulations. As a result, I expected that, in contrast to studies in the 'One-way design' group, those in the 'Interaction design' group would exhibit attenuation in the estimation of overall effect sizes.

6) Site of Study: Laboratory versus Online

Lastly, I considered the site of the study (laboratory vs. online) as a moderating variable impacting the estimation of overall effect size. Studies that were conducted in a controlled laboratory setting were coded as 'Laboratory' (k = 70). Studies that reported a data collection from online panels (e.g., Mturk) were coded as 'Online' (k = 33). Due to the controlled environment of a laboratory setting, such experiments could be expected to show considerably stronger effects than online studies where there is a greater likelihood of participants being distracted (Baumeister 2020). Thus, I predicted that laboratory studies would yield greater effect sizes than online studies.

Model Selection

The most common meta-analytical model, called fixed-effects model, is given by:

$$\hat{y}_i = \theta + e_i$$

where $\hat{y}_i$ is the observed effect size of study i, θ is the true underlying effect size and $e_i \sim N(0, \sigma_i^2)$ is the sampling error of the study which is assumed to be normally distributed. This model assumes that the true outcome θ is the same across studies.

Since I expected systematic differences between studies due to different study designs and heterogeneous manipulations and measurements, I did not assume the existence of one

true effect size underpinning all the reported effect sizes, but a distribution of effect sizes. For this reason, I utilised a random-effects model that is consistent with this assumption. This model is given by:

$$\hat{y}_i = \mu + u_i + e_i$$

where μ denotes the mean true effect size and $u_i \sim N(0, \tau^2)$ is the study-specific random effect that differentiates the true effect size of study i from the mean true effect size. In this way, τ^2 measures the variance or heterogeneity in the true effect sizes of the studies. All effect sizes and sampling errors are assumed to be independent of one another, which is consistent with my data structure of a single effect size per study.

Finally, in order to further account for heterogeneity in the true effect sizes, the random-effects model can be augmented by the addition of moderator variables, which yields the meta-regression or mixed-effects model:

$$\hat{y}_i = \beta_0 + \sum_q \beta_q x_{iq} + u_i + e_i$$

where x_{iq} denotes the moderator variables and β_0 denotes the regression's constant which captures the mean true effect size when all moderator variables take the value of 0.

The above models were estimated in Stata 16.

Results

Mean Effect Size

The mean effect size of the anthropomorphism manipulations on measures of anthropomorphism across 108 data points was d = 0.803 (95% CI [.718, .887], z = 18.60, p < .001), indicating a significant positive mean effect of anthropomorphism manipulations on perceived anthropomorphism. Results from a heterogeneity test showed the between studies variance equal to τ^2 = .156, which was statistically different from zero (Q (107) = 565.88, p < .001). Furthermore, the I^2 statistic was 83.72%. Thus, 83.72% of total variance in the effect sizes was due to true heterogeneity and not to sampling error. The 95% prediction interval, which shows the distribution of true effect sizes around the mean value, was 0.016 to 1.590, indicating a large variation of effect sizes across different studies.

Corrections for Measurement Error

I corrected for measurement errors using the reliability measures of perceived anthropomorphism as measured by Cronbach's alpha or the correlation coefficient (Grewal, Puccinelli and Monroe 2018). Scholars have highlighted the importance of correcting measurement errors in individual studies used in the meta-analysis, because these errors can decrease the effect sizes (Cooper et al. 2009; Hunter and Schmidt 2004; Geysken et al. 2009; Grewal, Puccinelli and Monroe 2018). Hence, following the formula provided by Hunter and Schmidt (2004), I divided each effect size by the square root of the corresponding reliability measure. Studies that employed a single item to assess perceived anthropomorphism were assigned a reliability measure of '1'. Ten studies did not report reliability measures. For those, I used the average of all reported values across studies as suggested by Geysken et al. (2009).

After correcting for measurement errors, the mean effect size increased slightly to d = 0.862 (95% CI [.775, .949], z = 19.33, $p < .001$). Results from a heterogeneity test showed that the between studies variance was $\tau^2 = .169$, which was statistically different from zero (Q (107) = 603.99, $p < .001$). Similar to the analysis without correction for measurement errors, the I^2 statistic was 84.74%. The 95% prediction interval was also similar to the uncorrected one, 0.042 to 1.682. Hence, correcting for measurement errors did not substantially change the results. Nonetheless, I used the corrected effect sizes for all subsequent analyses.

Outliers Detection and Robustness Test

Meta-analysis results can be sensitive to the presence of outliers. To classify a study's effect size as an outlier, scholars have suggested Huffcutt and Arthur's (1995) sample-adjusted meta-analytic deviancy statistic (SAMD). Compared to other traditional outlier detection techniques, the SAMD procedure weighs each individual study according to its sample size, instead of giving each study equal weight (Geysken et al. 2009; Grewal et al. 2018).

To identify extreme outliers, Huffcutt and Arthur (1995) suggest plotting the absolute SAMD values in ranked order. SAMD values that are above the gradual slopes are identified as outliers (Beal et al. 2005; Huffcutt and Arthur 1995). Following this procedure, I plotted the SAMD values in *Figure A2*. As can be seen, the cut-off point was identified between the SAMD values of 3.04 and 3.46. Hence, I categorised as outliers 14 studies that had SAMD values of 3.46 or higher.

Excluding these 14 studies from the analyses, I tested the sensitivity of the effect size to the presence of outliers. The mean effect size across the remaining 94 studies was d = 0.785 (95% CI [.725, .844], z = 25.91, p < .001), suggesting that the removal of outliers slightly decreased the estimated mean effect size. The between studies variance was significantly reduced to τ^2 = .045, which was statistically significant (Q (93) = 216.92, p < .001). Additionally, the ratio of true heterogeneity to total variation in observed effects dropped from high to moderate levels (I^2 = 57.77%), indicating that some of the heterogeneity from the original data set might be caused by outliers. Finally, the 95% prediction interval showed a range of 0.362 to 1.208, which was substantially narrower than in the sample that included the outliers. Given that the between studies variation remained significant, I further conducted a meta-regression analysis to assess whether the identified moderating variables explain the residual heterogeneity.

Meta-Regression Model

To quantify the impact of moderators on the overall effect size, following Scheibehenne et al. (2010) I created a hypothetical baseline study. This baseline study induced anthropomorphism via visual manipulations (M_1: type of manipulation - *Visual*), where the manipulation method did not correspond to the measurement items employed to assess anthropomorphism (M_2: IV-DV matching - *No*), and perceived anthropomorphism was framed subjectively (M_3: measurement items - *Subjective*). Additionally, the baseline study assessed anthropomorphism as a manipulation check within the main study rather than in a different pre-test study (M_4: assessment technique – *Manipulation check*), it utilised only anthropomorphism manipulation (M_5: type of design – *One-way design*) and the study was conducted in a lab (M_6: site of study – *Laboratory)*. The mean effect size of this hypothetical study was captured by the regression's constant and all other coefficients represented relative differences in effect size compared to the baseline study.

Focal Results

I first examined the manipulation type as a single moderator on the overall effect size for the dataset without outliers (N = 94). As can be seen in *Table A2* column 1, using visual manipulations as the baseline, the R^2 statistic, which measures the proportion of the between study variance explained by the model, was 0.00% indicating no explanatory power. As a result, this moderator did not have a significant explanatory power on the residual

heterogeneity, as indicated by the similar between studies variance τ^2 = .046 (Q (91) = 215.47, p < .001) and I^2 = 58.45%. The effect size of the baseline study was β_0 = .827 (z = 11.76, p < .001). The meta-regression showed that there were no significant differences in the overall effect size when participants were exposed to verbal manipulations (β_{Verbal} = -.071, z = -.82, p = .411) or combined manipulations ($\beta_{Combination}$ = -.034, z = -.40, p = .690) compared to visual manipulations. In addition, I did not find a significant difference between verbal manipulations and combined manipulations ($\beta_{Combination}$ = .037, z = .55, p = .586) when using verbal manipulations as the baseline as seen in *Table A3* column 1.

Next, I replicated the previous analysis by also including the matching moderator (M_2) that captured whether the manipulation and the measure of perceived anthropomorphism were congruently associated. There was a substantial reduction of between studies variance τ^2 = .037 (Q (90) = 188.90, p < .001) and I^2 = 52.70% while R^2 increased to 16.89% as seen in *Table A2* column 2. The results showed that participants in studies utilising non-matching manipulations and measures (i.e., visual manipulations and measuring humanlike mind, or a combination of humanlike mind and physical appearance) reported significant perceived anthropomorphism (β_0 = .722, z = 9.79, p < .001). However, participants in studies that matched visual manipulations only with perceived humanlike physical appearance measures reported greater perceived anthropomorphism compared to the previous case ($\beta_{Matching}$ = .281, z = 3.03, p = .002). This finding supported my focal argument, indicating that visual manipulations signalling the humanlike physical appearance of target products have a stronger impact on measures capturing the perception of humanlike physical appearance, compared to those capturing the perception of a product possessing a humanlike mind.

Similarly, when using verbal manipulations as the baseline in *Table A3* column 2, participants in studies utilising verbal manipulations on non-matching measurements reported significant perceived anthropomorphism (β_0 = .501, z = 5.20, p < .001). However, participants in studies with verbal manipulations on matching measurements reported greater perceived anthropomorphism compared to the non-matching case ($\beta_{Matching}$ = .281, z = 3.03, p = .002). In support of my focal argument, this result showed that verbal manipulations featuring target products possessing a humanlike mind have a stronger impact on measures capturing the perception of a humanlike mind, compared to those capturing the perception of the product possessing humanlike physical appearance.

Taken together, these results indicated that visual manipulations had a stronger effect on items that measured perceived humanlike physical appearance, while verbal ones had a stronger effect on items that measured perceived humanlike mind.

Exploratory Results

I also examined the impact of the two different types of verbal manipulations on the overall effect size estimation. When using verbal cues as the baseline, there was no significant difference from verbal instructions ($\beta_{\text{Verbal instructions}}$ = -.100, z = -.97, p = .331) as seen in *Table A3* column 3. That is, participants reported similar levels of perceived anthropomorphism irrespective of whether they were exposed to verbal cues or verbal instructions. This result was robust when including the matching moderator (M_2). Specifically, as can be seen in *Table A3* column 4, participants in studies utilising verbal cues on non-matching measurements reported similar levels of perceived anthropomorphism compared to participants exposed to verbal instructions on non-matching measurements ($\beta_{\text{Verbal instructions}}$ = -.146, z = -1.51, p = .130). Similar results held for verbal cues and verbal instructions on matching measurements.

Finally, I performed further exploratory analyses to assess the impact of the inclusion of all moderators on the overall effect size (i.e., 'Type of manipulation', 'IV-DV matching', 'Measurement items', 'Assessment technique', 'Type of design' and 'Site of study'). The inclusion of the additional moderators reduced the R^2 to 10.67% as they were not statistically significant, while the between studies variance slightly increased τ^2 = .042 (Q (81) = 177.55, p < .001) and I^2 = 55.09% as seen in *Table A2* column 5. Importantly, my variable of interest, matching, remained statistically significant (β_{Matching} = .269, z = 2.61, p = .009) which showed the robustness of the focal result.

Repeating this analysis with the verbal subgroups in *Table A2* column 6, the R^2 was reduced to 15.62% while the between studies variance increased to τ^2 = .039 (Q (80) = 168.32, p < .001) and I^2 = 53.57%. Matching was the only statistically significant moderator (β_{Matching} = .269, z = 2.83, p = .005).

In conclusion, the exploratory results showed that only the matching variable was statistically significant, consistent with the idea that visual and verbal manipulations produced distinct effects on the two dimensions of perceived anthropomorphism.

Publication Bias

To assess whether the meta-analysis results could be influenced by publication bias, I first used the funnel plot to visualise the relationship between individual effect sizes and their standard errors. In the absence of publication bias, the studies should be distributed symmetrically around the overall effect size, because the sampling errors are independent with each other. In addition, small sample studies should exhibit larger variation of effect sizes, creating a funnel shape in the plot. The funnel plot can be enhanced by adding contour lines to determine the statistical significance of the effect sizes (Peters et al. 2008). Publication bias is likely to exist in the absence of studies reporting null effects. In *Figure A3* (see Appendix A), I present the funnel plot of all studies in my analysis, enhanced with contour lines of 95% and 99% significance levels. As can be seen in the graph, there are no studies in the non-significant region (dark grey area in the graph), which strongly indicates the presence of publication bias.

To formally test for the presence of publication bias, I used the Egger regression test and skewness test in each set of studies (Egger et al. 1997; Lin and Chu 2018). The Egger test detects publication bias via the presence of small-study effects. Specifically, it indicates the presence of publication bias if studies with small sample sizes (and hence large standard errors) have disproportionally large effect sizes. The skewness test quantifies the magnitude of publication bias by estimating the skewness of the effect size distribution. The test indicates the presence of publication bias if there is a positive skewness, which implies that studies with small or negative effect sizes are omitted. Both the Egger regression test and the skewness test indicated the presence of significant publication bias across manipulation methods (p = .008) as seen in *Table A4*. At the subgroup level, the visual manipulations did not exhibit significant publication bias (p = .340), nor did the verbal cues subgroup (p = .660) or the verbal instructions subgroup (p = .122) as seen in *Table A5*. However, the combined manipulations showed significant publication bias (p = .004). To conclude, my findings indicated the presence of publication bias only in the combined subgroup.

Finally, in order to provide an estimation of the overall effect size corrected for publication bias, I utilised the three-parameter selection (3PSM) model developed by Iyengar and Greenhouse (1988). Selection models assume that the selection of studies to be published depends on their statistical significance and calculate a weight function that assign corresponding probabilities (Marks-Anglin et al. 2021). Specifically, the 3PSM model uses a weight function that calculates the probability that a study with non-significant results is

published compared to the probability that a study with significant results is published. The model then uses these weights to estimate the overall effect size, correcting for publication bias. Fitting the model to my data, the results showed a decrease of the overall effect size, d = 0.627 (95% CI [.465, .789], z = 7.58, p < .001), consistent with the assumption of the presence of publication bias. Despite this correction, the overall effect size of anthropomorphism manipulations on perceived anthropomorphism remained statistically significant.

General Discussion

Key Findings

Adopting the most common measures of perceived anthropomorphism that mainly focused on humanlike mind items, Studies 1-3 consistently showed that verbal manipulations predominantly trigger perceptions of a humanlike mind, in contrast to visual manipulations. Further evidence from tests on a single item of perceived humanlike physical appearance in Study 2 revealed that only visual manipulations fostered the perception of a humanlike physical appearance, but not verbal manipulations. These findings indicate that humanlike physical appearance and humanlike mind exhibit distinct elicitation processes. Yet, given that Studies 1-3 mainly relied on items assessing the perception of a humanlike mind, the present finding on the elicitation of humanlike physical appearance is not readily generalisable.

To gain comprehensive understanding and systemically test my focal argument, I conducted a meta-analysis of 108 available effects from experimental studies that tested the effects of anthropomorphism manipulations on perceived anthropomorphism. Findings from meta-regressions of 94 effects after removing outliers indicated that visual manipulations heightened the perception of humanlike physical appearance, while verbal manipulations heightened the perception of a humanlike mind. These findings were robust when controlling for other study-level moderators.

My findings provide several novel insights. First, they contribute to the ongoing debate on the triggering factors of anthropomorphism (c.f. Epley 2018; Golossenko et al. 2020; Yang et al. 2020). More specifically, my findings indicate that anthropomorphism manifests through various representations, confirming its multidimensional nature. In contrast to the assumption that anthropomorphism is solely triggered by the perception of a humanlike mind of the target product (c.f. Epley 2018; Epley et al. 2013; Herak et al. 2019; Schroeder and Epley 2016; Waytz et al. 2010), my findings showed that signalling humanlike physical

appearance of a target product is also a sufficient trigger to elicit anthropomorphism. Moreover, in contrast to the current multidimensional assumption that considers humanlike physical appearance and humanlike mind as conceptually correlated dimensions reflecting the same underlying focal construct (c.f., Golossenko et al. 2020; Yang et al. 2020), my findings elucidated that these dimensions represent different facets of it and provide distinct routes towards its elicitation.

Second, my findings provide further insight on the construct of anthropomorphism, by evaluating the relationship between the focal construct and its key dimensions. Previous developed scales on perception of anthropomorphism combined humanlike physical appearance and humanlike mind within the same instrument, yet showed low convergent validity among these two key dimensions when participants were exposed to combined manipulations (c.f., Golossenko et al. 2020; Ruijten et al. 2019). The results from Golossenko et al. (2020) and Ruijten et al. (2019) can be explained in accordance with my findings that the two key dimensions elicit anthropomorphism in distinct ways.

Theoretical Implications

Prior research has relied on a heterogeneous set of operationalisations of anthropomorphism in the literature, with ongoing debate on the triggering factors of anthropomorphism. To provide clarity on this debate, I distinguished its two key dimensions rather than taking the common approach of interchangeably using them. I then mapped these key dimensions of anthropomorphism onto their corresponding manipulations and measures. Combining findings from a multi-method approach, I consistently found that various manipulations exhibited differential representations of eliciting anthropomorphism, depending on their conceptual distances to the dimensions of anthropomorphism displayed in the measurement items. Hence, the current chapter suggests that humanlike physical appearance and humanlike mind are both sufficient triggers, but they should be treated as distinct from each other rather than as interchangeable. This is because my findings indicate that these two key dimensions can be most strongly induced by visual and verbal manipulations respectively and captured by measurement items that tap into them.

In addition, building on these insights, I suggest an alternative way of thinking of the concept of anthropomorphism. Scholars have commonly considered anthropomorphism as a reflective construct when assessing its perception, expecting that various dimensions of anthropomorphism can be perceived simultaneously, irrespective of the elicitation methods

(Golossenko et al. 2020). Yet, this assumption was not empirically supported by the findings from Ruijten et al. (2019), which indicated low correlations between various perceived anthropomorphism measures (i.e., when comparing measurement instruments that focus on a combination of humanlike physical appearance and humanlike mind to those that tap into humanlike physical appearance and humanlike mind individually). In other words, different measures of anthropomorphism could capture different facets of this construct. Given this, it is also plausible to explain my current findings following a formative construct assumption (Edwards and Bagozzi 2000; Jarvis et al. 2013), where dimensions of anthropomorphism are causes of the construct (i.e., formative construct assumption), rather than consequences of it (i.e., reflective construct assumption). That is, rather than assuming that inducing anthropomorphism causes the perception of humanlike physical appearance and humanlike mind simultaneously (c.f. Golossenko et al. 2020), it is possible that these two key dimensions define what anthropomorphism entails, so removing either of those can change the interpretation of this construct. This would be consistent with my studies' findings that constraining the measures of anthropomorphism to only reflect humanlike physical appearance or humanlike mind changes how participants interpret anthropomorphism manipulations.

Moreover, the current chapter invites a reflection on the construct validity of measures and manipulations of anthropomorphism, by considering the dimensions of humanlike physical appearance and humanlike mind as distinct from each other, as well as their relationship to the focal construct of anthropomorphism. Although existing scales assessing the perception of anthropomorphism have highlighted the relative importance of items within the same survey relating to a humanlike mind compared to those relating to humanlike physical appearance (Golossenko et al. 2020; Ruijten et al. 2019), they only did so utilising combined manipulations which may not be readily generalisable when using visual or verbal manipulations only. To this end, my findings on the distinct routes underlying the elicitation of humanlike physical appearance and humanlike mind offer a clearer documentation of the various ways to elicit anthropomorphism. Thus, when designing measures to adequately capture the elicitation of anthropomorphism, studies should consider setting up items that are conceptually related to the key dimensions of anthropomorphism embedded in their manipulations.

Lastly, results from the current chapter also offer an explanation to the failed replication attempts in the anthropomorphism literature. To illustrate, Williams et al. (2015) failed to replicate the results of Ahn et al. (2014) that anthropomorphism increases

compliance intention to prosocial appeals, even though they disentangled the anthropomorphic visual manipulations from the confounding factors present in the original study (i.e., emotional cues embedded in the anthropomorphism manipulation). Although this replication attempt used similar manipulation methods and procedures, larger sample sizes, and diverse participants, the findings indicated the existence of other factors that are unmeasured or not manipulated in the original set of studies that may have contributed to the failed replication. A close examination of the design of this replication study shows that the authors utilised combined manipulations, but only assessed the humanlike physical appearance of the stimuli. Such operationalisation may underestimate the effect of combined manipulations on perceived anthropomorphism.

Practical Implications

The current chapter offers several opportunities and potential implications for marketing practitioners, especially at the stage of designing anthropomorphism products and brands. First, the current findings can be deployed in the product ideation stage. Given that there are various ways of eliciting anthropomorphism in products and brands (Gouda 2016; Newcomb 2019), marketers should acknowledge the distinction between these various manifestations of anthropomorphism, and design anthropomorphic features according to these key dimensions. That is, since the current chapter offers the insight that humanlike physical appearance and humanlike mind act as distinct dimensions underlying the elicitation of anthropomorphism, marketing practitioners and product designers should consider the effects of visual and verbal manipulations on eliciting separate dimensions of anthropomorphism. For instance, some marketing campaigns have designed anthropomorphic features to guide their consumers to consider a target product as having a humanlike mind. In cases like this, the use of verbal cues or instructions would yield better efficacy in achieving this goal, instead of using visual ones.

Second, my findings may also help practitioners develop marketing tactics to effectively induce product anthropomorphism, specifically for technological products. For instance, prior research has shown that when technological agents appear to closely resemble humans, consumers might experience discomfort caused by the uncanny valley effect (i.e., the tendency for robots to induce negative emotional reactions when they resemble a human too closely; Waytz et al. 2010). Therefore, when ascribing anthropomorphic features to technology agents that are more associated with bearing a humanlike mind (i.e., agency,

Crolic et al. 2022; Gray et al. 2007), companies can focus on utilising verbal manipulations solely to elicit the humanlike mind of technological products.

Lastly, the current findings offer potential tools for market research practitioners to better understand the occurrence of eliciting anthropomorphism in products and brands. The distinct dimensions of anthropomorphism and their individual elicitation processes shed light on the best ways to design surveys assessing the perception of anthropomorphism. Thus, to achieve better accuracy of people's perceptions of these targets, researchers should consider setting up items that are congruently associated to the way anthropomorphism is elicited.

Limitations and Future Research

As the first attempt to systematically assess the impact of humanlike physical appearance and humanlike mind on the elicitation of anthropomorphism, there are several limitations in the present analysis. First, in Studies 1-3, I mainly focused on assessing the perceived humanlike mind of the target entity, representing the most common approach measuring perceived anthropomorphism in the literature. Future studies should also aim to address the impact of humanlike physical appearance on the elicitation of anthropomorphism to provide further insights on this dimension.

Second, the literature (and hence my meta-analysis) has mainly distinguished the two key dimensions of humanlike physical appearance and humanlike mind of the target entity (c.f., typology proposed by Waytz et al. 2010). However, one may speculate whether other alternative forms of anthropomorphising exist. For instance, other elicitation methods such as humanlike vocal cues (e.g., Schroeder and Epley 2016), or humanlike movements (e.g., Morewedge, Preston and Wegner 2007) have not been included in my analysis, due to the small number of studies. Future studies can test whether these methods are distinct from visual and verbal manipulations in eliciting anthropomorphism.

Third, due to the lack of a clear-cut indication of the effect of verbal instructions on perceived anthropomorphism, the current chapter makes the assumption that they lead to the perception of a humanlike mind, which may be a simplified way to address the efficacy of verbal instructions. For instance, Yang et al. (2020) speculated that verbal instructions could elicit either humanlike physical appearance or humanlike mind, depending on which dimensions of anthropomorphism participants would pay attention to. In my analysis, I assumed that verbal instructions elicit the attribution of a humanlike mind through thinking of unobserved qualities of the target product, but people who are visualisers may be more prone

to use vivid imagery and attribute humanlike physical appearance instead (Wyer Jr., Jiang and Hung 2018). Future studies that rely on verbal instructions to induce anthropomorphism should aim to provide clarity on its corresponding elicitation process.

Lastly, the current findings indicate the potential consideration of a multidimensional formative model to better understand the construct validity of anthropomorphism, although this consideration remains untested. Future research can test the potential causal relationship between dimensions of anthropomorphism and the focal construct, i.e., specifying test models comparing formative and reflective models (Edward and Bagozzi 2000; Jarvis et al. 2013; Law, Wong and Mobley 1998; MacKenzie, Podsakoff and Podsakoff 2011). In this way, one can provide further clarity on ways to adequately define the construct of anthropomorphism and to accurately measure it.

Conclusions

Extensive research has shown the effects of anthropomorphism on the perception of target products, yet has nevertheless interchangeably used its two dimensions of humanlike physical appearance and humanlike mind. Various suggestions have been made on the triggering factors eliciting anthropomorphism, but it remains unclear what this entails and what is the most effective way to induce it.

My research contributes to the literature by combining evidence from experimental studies and a meta-analysis testing the effects of visual and verbal manipulations on eliciting perceived anthropomorphism, by mapping them onto corresponding measures reflecting dimensions of anthropomorphism. I have shown that visual and verbal manipulations induce distinct perceptions of anthropomorphism. More specifically, findings from meta-analysis confirm that visual manipulations heightened the perception of humanlike physical appearance of the target entity, while verbal manipulations heightened the perception of a humanlike mind. These findings are in contrast to some theoretical arguments that a humanlike mind is the necessary and sufficient trigger of anthropomorphism, but also to arguments suggesting that humanlike physical appearance and humanlike mind are both sufficient triggers with different intensities. Instead, my findings suggest that each dimension is distinct and reflects different facets of anthropomorphism. The findings provide important insights into the construct of anthropomorphism and its relationship to its key dimensions. They provide suggestions to researchers and practitioners on how to enhance the efficacy of the design of anthropomorphism manipulations, as well as the measures of this construct.

Chapter 3

A Meta-Analysis on the Effects of Anthropomorphism in Influencing Consumer Behaviour

Introduction

The previous chapter showed that visual and verbal manipulations affect different facets of anthropomorphism. However, it remains unclear whether this can have differential effects on consumer responses. Indeed, several scholars have highlighted the need to not only understand the effectiveness of anthropomorphism manipulations in eliciting this focal construct, but also their downstream consequences on consumer responses (Epley 2018; Yang et al. 2020). Many studies have shown that anthropomorphised products or brands affect consumer responses toward them, such as choice, evaluation, purchase, usage, and consumption of anthropomorphic products (e.g., Aggarwal and McGill 2007; Coormans and Geuens 2019; Han et al. 2019; Hart and Royne 2017; Huang, Wong and Wan 2019; Hur, Koo and Hoffmann 2015; Kim and McGill 2018; Kim and Swaminathan 2020; Koo, Oh and Patrick 2019; Puzakova and Aggarwal 2018; Puzakova and Kwak 2017; Wan, Chen and Jin 2017), which together reflect consumers' direct judgements of and behaviours towards the target objects.

Prior research has suggested that perceiving brands or products as having humanlike physical appearance can create a more positive impression and thus facilitate a more favourable attitude towards them as a result of their similarities with human forms (Cooremans and Geuens 2019; Koo, Oh and Patrick 2019; Landwehr, McGill and Hermann 2011; Maeng and Aggarwal 2018). In addition, the attribution of a humanlike mind can lead consumers to assume that the product has its own intentions and judgments. This in turn can lead to positive or negative consumer responses due to the more in-depth mind attribution process, which makes consumers treat the product as a moral agent, e.g., by judging its intentionality, trustworthiness, blameworthiness etc. (Hur et al. 2015; Kim and McGill 2011, 2018; Kwak, Puzakova and Rocereto 2015; MacInnis and Folkes 2017; May and Monga 2014; Puzakova et al. 2013; Waytz, Heafner and Epley 2014). Yang et al. (2020) further speculated that qualitative differences may exist between humanlike physical appearance and humanlike mind in eliciting anthropomorphism and affecting consumer responses, and that these differences can be assessed through the various anthropomorphism manipulations. This is because visual manipulations approximating a human face or body are associated with the attribution of humanlike physical appearance, while verbal manipulations indicating that the target entity has its own mental state are associated with the attribution of a humanlike mind. Given the different predictions regarding the efficacy of the various facets of anthropomorphism in influencing consumer responses, a systematic evaluation of the extant literature could provide clarity on the different ways anthropomorphism affects consumers.

Two meta-analyses have attempted to provide a systematic evaluation of the effects of anthropomorphism on consumer responses (Blut et al.2021; Velasco et al. 2021). However, these studies focused on single outcome measures (i.e., product evaluation and usage intention of service robots). Specifically, Velasco et al. (2021) found a positive effect of anthropomorphic appeals on product evaluations when consumers are faced with high salience of uncertainty. Blut et al. (2021) found that anthropomorphism positively correlates with consumers' usage intention as regards service robots. Moreover, this study evaluated only one specific application of anthropomorphism (i.e., robot design features: comparing the impact of physical features such as embodiment with that of non-physical features such as emotions, voice, gesture, and mimicry on robot usage intention). This clearly offers only limited insights into the effectiveness of anthropomorphism in products and brands on consumer responses. Thus, the literature still lacks a meta-analysis that conceptually differentiates the various anthropomorphism manipulations in products and brands and assesses their impact on all existing consumer responses. This would provide generalisable insights on the downstream consequences of anthropomorphism manipulations.

To this end, the current chapter aims to provide a systematic evaluation of the effectiveness of different anthropomorphism manipulations in affecting consumer responses, by including all types of outcome measures rather than focusing on a single one. In this way, this chapter provides several contributions. On a theoretical level, it will allow researchers to gain a precise understanding of the effects of various anthropomorphism manipulations on consumer responses. On a methodological level, by utilising a multi-level multivariate meta-analytical approach, it provides accurate estimations of overall effect sizes for different consumer responses within the same analysis, which can help researchers in the field to have better predictability on these responses. On a practical level, this research can benefit companies and practitioners that aim to optimise the design of anthropomorphic marketing stimuli in order to achieve desirable consumer responses.

Conceptual Foundations

Manipulations of Anthropomorphism and their Impact on Consumers

In order to manipulate anthropomorphism, the extant literature has relied on various methods, including the use of visual and verbal manipulations (MacInnis and Folkes 2017; Waytz et al. 2010; Yang et al. 2020). Although the literature has used these manipulations interchangeably and often combined them, there are indications that they may elicit different ways of anthropomorphising leading to different consumer responses.

As regards visual manipulations, it has been shown that from an early age humans develop a selective sensitivity to cues that morphically resemble human faces (Mondloch et al. 1999; Windhager et al. 2009), even if they were displayed in an abstract manner (Thalyer and Schiff 1969; Windhager et al. 2009). It is for this reason that consumers detect faces in daily objects (Guthrie 1993). Prior research has considered that consumers can readily see these visual manipulations and automatically perceive target products as possessing similarities to surface-level humanlike characteristics (Golossenko et al. 2020; Yang et al. 2020). This perception has been associated with the activation of human schema, which can translate into positive evaluations of the target products when it is matched with the features of the schema (Aggarwal and McGill 2007). Consistent with this argument, studies have found that visual manipulations can facilitate more positive evaluation of target products (Aggarwal and McGill 2007) and make them more appealing (Cooremans and Geuens 2019; Koo, Oh and Patrick 2019).

On verbal manipulations, Yang et al. (2020) have speculated on their association with the activation of mind attribution. Research has highlighted the importance of mind attribution, by considering it as a more in-depth form of anthropomorphising (Epley 2018; Kim and McGill 2011, 2018; Waytz, Cacioppo and Epley 2010). Evidence from neuroscience also shows that when people are making anthropomorphic judgments on inanimate entities, the same neural system is activated as the one related to making inferences about another person's mental state (Castelli et al. 2000; Cullen et al. 2014; Epley, Schroeder and Waytz 2013). Yet, some scholars have suggested that participants may need to engage in an effortful attention and motivated reasoning process in order to infer the humanlike mind of target products (Adolphs 2009; Epley 2018; Lin, Keysar and Epley 2010). As a result, the presence of a humanlike mind is considered as a deeper but more effortful progression of anthropomorphism, which in turn induces the attribution of social beliefs and agency normally only afforded to other human beings (Kim and McGill 2011, 2018; Yang et al. 2020). Such beliefs make consumers judge the target entities according to their attributes such as trustworthiness, fairness and blameworthiness (Kwak et al, 2015; MacInnis and Folkes 2017; Puzakova et al. 2013; Waytz et al. 2014), which in turn can lead to positive or negative consumer responses.

Finally, looking at combined manipulations, there is scant discussion as to whether they can improve consumer responses compared to the impact of individual components, even though these combinations have been extensively used in the literature. Velasco et al. (2021) found in a meta-analysis that using multiple anthropomorphic cues within the

manipulation is less likely to lead to positive product evaluations compared to using a single cue, although they did not provide a theoretical justification for this finding. In addition, the authors did not indicate whether these cues referred to a combination of visual and verbal ones (as opposed to multiple cues from the same type of manipulation), and they focused on a single outcome of product evaluation which may not be generalisable to a broader conclusion of influencing consumer responses.

Given the above insights, I argue that visual and verbal manipulations affecting different facets of anthropomorphism can impact consumer responses in different ways. On the one hand, visual manipulations offer the opportunity to consumers to perceive the similarities between objects and humans, increasing the likelihood of the activation of a human schema, which may facilitate impression formation of the entity possessing superficial humanlike traits (Golossenko et al. 2020; Maeng and Aggarwal 2018; Srull and Wyer 1989). On the other hand, verbal manipulations offer the opportunity to consumers to infer and engage with the humanlike mind of a target object which may influence their interactions with it in a social setting (Chandler and Schwarz 2010; Golossenko et al. 2020; Hart and Royne 2017).

On the empirical side, few studies have compared visual and verbal manipulations for their effects on consumer responses, and findings overall have been mixed. Ding et al. (2020) found that visual manipulations are more effective than verbal manipulations in affecting participants' willingness to recycle. This is because, according to the authors, visual manipulations make it easier for participants to feel psychologically connected to a target object (in their case a recyclable package) than do verbal ones. Lee et al. (2015) found differential main effects of visual and verbal manipulations on trusting a target object. That is, visual manipulations significantly increased affective trust (e.g., the extent to which participants perceive the driving agent as "likable", "enjoyable" and "positive", adapted from Soh et al. 2009), but not cognitive trust (e.g., the extent to which participants perceive the driving agent as "credible", "reliable" and "accurate"). In contrast, verbal manipulations significantly increased both affective and cognitive trust, but showed stronger effects on cognitive trust. This is because humanlike physical appearance embedded in visual manipulations is easily recognised by participants so they can immediately develop affective trust based on their emotional response. On the other hand, perceiving a humanlike mind requires a more in-depth rational engagement with the target object, which then fosters cognitive trust.

In summary, prior research has shown that there are different ways of anthropomorphising a target product. However, there is a lack of consensus or empirical assessment to clarify whether and to what extent different anthropomorphism manipulations have the ability to influence consumer responses. Moreover, given that the manipulations are associated with different facets of anthropomorphism, understanding their relative effectiveness can shed light on how to use anthropomorphism manipulations to effectively influence consumers. To address this, the current chapter proposes to evaluate the relative impact of visual, verbal and combined manipulations on consumer responses.

Comparing Various Anthropomorphism Manipulations

Given the above insights, it remains unclear whether anthropomorphism manipulations affect consumer responses in different ways and whether they are equally effective. Beyond the anthropomorphism literature, evidence from the human-to-human communication literature suggests that visual and verbal information may exert differing influences on the evaluation of targets (Gesn and Ickes 1999; Hall and Schmid Mast 2007; Schroeder and Epley 2015; Schroeder and Epley 2016; Schroeder, Kardas, and Epley 2017). Specifically, scholars have shown that vocal manipulations indicating the presence of a humanlike mind through a voice message can lead to more positive evaluation of the communicator's thoughtfulness and intelligence, compared to visual manipulations that signal their biological life through visual movements (Schroeder and Epley 2015; Schroeder and Epley 2016; Schroeder et al. 2017). Analogously, I expect that visual manipulations would suggest the presence of humanlike physical appearance but not necessarily the mental capacity of the non-human entity. In contrast, verbal manipulations would convey the entity's mental state, leading to stronger consumer responses towards these products as compared to when visual ones were used. As a result, I argue that verbal manipulations will elicit stronger consumer responses as compared to visual ones (***H1***).

Moreover, the human-to-human communication literature has suggested that combining visual and verbal information does not improve participants' accuracy of inferring a person's thoughts and feelings compared to using verbal information only (Gesn and Ickes 1999; Hall and Schmid Mast 2007). This indicates that visual information is redundant in facilitating inferences of others' mental states (Schroeder and Epley 2015). Studies have also shown that when combining visual and verbal information in printed advertisements, visual information can be redundant in inducing consumers' formation of mental imagery about the

products' attributes (Unnava and Burnkrant 1991). Based on these insights, it is possible that, because of the visual redundancy effect, combined manipulations do not enhance consumers' formation of mental imagery of the products' anthropomorphic attributes. In the same vein, I argue that combined manipulations will elicit stronger consumer responses compared to visual ones (***H2***). This is because I expect that combined manipulations will elicit similar effects to verbal ones due to the visual redundancy effect.

To test these hypotheses, I conducted a meta-analysis of 259 effects (N = 23,060). Utilising a multi-level multivariate approach, the current chapter provides estimations of overall effect sizes for different consumer responses within the same analysis, offering a generalised estimation of the effectiveness of various anthropomorphism manipulations in influencing consumer responses.

Method

Study Retrieval

Literature Search

Studies examining the effects of anthropomorphism manipulations on consumer behaviour were collected via different databases and retrieval attempts, covering both published and unpublished work. Regarding published work, I searched multiple databases and conference programs between October 2020 and December 2020. In particular, the literature was located via Business Source Complete, PsycINFO, Web of Science, Scopus, ABI/INFORM, Science Direct, Google Scholar and ProQuest Dissertations and Theses Global.

As can be seen in *Table B1*, in order to locate relevant studies, I first set up key search terms using "(Anthropomorphism* OR "Anthropomorphic condition" OR Anthropomorphized* OR Anthropomorphizing* OR Humanizing* OR Humanized* OR Humanlike* OR Humanoid) AND (Consumer behavior* OR Buyer behavior* OR Consumer reaction* OR Consumer response* OR Consumption OR User satisfaction OR Engagement OR User interaction OR Mind perception OR Mind attribution OR Inference process)". Second, I manually searched for the keyword of "anthropomorphism" in conference programs, including the Association of Consumer Research (ACR) and Society of Consumer Psychology (SCP). Third, I checked all citations and reference lists of existing conceptual review papers and meta-analyses on anthropomorphism in consumer research (e.g., Aggarwal

and McGill 2016; Epley 2018; Golossenko et al. 2020; MacInnis and Folkes 2017; Velasco et al. 2021; Yang et al. 2020).

In terms of data collection on unpublished work, I called for suitable materials (e.g., working manuscripts, dissertation chapters, and conference posters) on the effect of anthropomorphism on consumer behaviour through electronic mailing lists including: Electronic Marketing List Information, The Society for Personality and Social Psychology, The Society for Judgement and Decision Making, and The Association for Consumer Research (April and June 2019). In total, 12 email responses were collected, including four unpublished manuscripts and conference working papers and four published papers. Lastly, I included two studies posted on open-source websites (i.e., replication archives, Nelson and Simmons 2020).

Inclusion Criteria

Studies were included if they met the following criteria:

1. Study design: to ensure a meaningful synthesis of effect sizes, I included studies with randomised experimental designs, rather than other types of research methods (e.g., correlational and qualitative studies, structural equation modelling). This selection decision was based on the following reasons: first, as suggested by Schmid et al. (2020), studies designed with random assignments facilitate an unconfounded estimation of treatment effects, which reduces the bias in a meta-analytical estimation. Second, considering the "fitness for purpose" of this focal meta-analysis (Thomas et al. 2021; Tugwell et al. 2010), including studies with experimental design only could allow for causal inference on the effects induced by anthropomorphism. Following this criterion, studies that measured individuals' tendency to anthropomorphise instead of using anthropomorphism manipulations were excluded (e.g., Karampournioti, Hennings and Wiedmann 2018; May and Monga 2014 - Study 1; Tam 2019).

2. Manipulation: studies that induced anthropomorphism via manipulating the presence (vs. absence) of anthropomorphic cues of the same target entity were considered as eligible studies. Participants in the treatment group were exposed to an anthropomorphised target entity, whereas participants in the control group were exposed to the same target entity without anthropomorphic cues. A full list of categorisation decisions on various anthropomorphism manipulations will be reported in the Variable Coding section.

Following this criterion, the following cases of studies were excluded: first, I excluded studies that compared various degrees of anthropomorphic conditions in the same study design without control conditions (e.g., Ding et al.2020 - Study 2; Landwehr et al. 2011; Kim, Schmitt and Thalmann 2019; Maeng and Aggarwal 2018; Yuan and Dennis 2019; Zhu, Wong and Huang 2019 - Studies 2 and 3).

Second, I excluded studies that compared the anthropomorphic condition with control conditions that did not use the same target entities. This applies to studies that: required participants to perform tasks related to other target objects (e.g., Chen 2014 - Experiment 4; Chen, Sengupta and Adval 2018 - Study 1); or compared the anthropomorphic entity with actual humans (e.g., Mende et al. 2019; Touré-Tillery and McGill 2015). I excluded these studies because they couldn't demonstrate the effectiveness of anthropomorphism manipulations on consumer responses towards the same given target entity.

Third, in some unpublished studies, the authors did not provide further documentation on how anthropomorphism was manipulated (e.g., Zou et al. 2017 - ACR proceeding), so they were excluded.

Lastly, four studies (i.e., Chérif and Lemoine 2019; Fan, Wu and Matila 2016; Yuan 2015; Yuan and Dennis 2019) met the inclusion criterion but were removed from the final dataset ex-post because they manipulated anthropomorphism through vocal cues, i.e., the attribution of a humanlike voice without the use of anthropomorphic verbal cues in the script. A fifth study (Waytz, Heafner and Epley 2014) was also excluded because of the additional manipulation in the vocal condition involving participants' familiarity with the autonomous vehicle, which was not present in the control condition. I did not include this set of studies in my sample as they would not have provided a reliable estimate of the effect of vocal cues due to their limited number and possible elicitation of different facets of anthropomorphism.

3. Dependent variables: The included studies examined different consumer responses as dependent variables. Specifically, the measures needed to provide insights on participants' responses directly related to the target entity itself in a consumption-based context (i.e., consumers' direct judgements of and behaviours towards the target objects). For instance, measures like purchasing, using, or any downstream consequences that reflected participants' decisions or evaluations regarding the target entity were included (e.g., replacement intention, Chandler 2010; Chandler and Schwarz 2010).

Following this criterion, I excluded studies that assessed participants' interpretations about themselves (e.g., Lee 2010: participants' confidence in their own evaluation of their own performances), responses related to situations (e.g., Chandler 2010 Chap 9: appraisal of the situation or participants' personal responsibility for the event; Reimann, Nuñez and Castaño 2017- Study 3: changes in the pain experienced from recalled situations), or other responses that lacked direct indication of consumption-based recommendations (e.g., Schneider et al. 2018, 2019: anthropomorphised digital learning materials affect students' learning outcomes; Uzun and Yildirim 2018).

Additionally, I excluded studies that measured participants' responses unrelated to the target entities, i.e., participants' subsequent decisions in other contexts (e.g., Aggarwal and McGill 2012; Chen, Chen and Yang 2020: anthropomorphised emotions affect participants' emotional experience in prompted situations; Nenkov and Scott 2014 - Study 1; Sacchi, Riva and Brambilla 2013: the impact of anthropomorphised nature on helping victims of natural disasters).

Lastly, since the vast majority of collected studies have assessed consumer responses as immediate responses towards the stimuli, I excluded three longitudinal experimental studies that assess delayed responses to the stimuli (i.e., Kim, Sung and Moon 2020; Simionescu 2020; Uzun and Yildirim 2018), as they require different meta-analytical modelling techniques due to the dependency induced by measuring responses in different time points (Jackson et al. 2020).

4. Data sufficiency: Studies needed to have sufficient information for computing effect sizes, or available test statistics to be converted into the effect sizes metrics of interest (i.e., Cohen's *d*) to be included in the sample. This includes studies reporting available raw means, *F*-values, *t*-values, or chi-square statistics. A more detailed overview of effect size calculation and transformation will be documented in the next section.

5. Language: Studies were restricted to English language manuscripts only.

As can be seen in *Figure B1*, the database search and other sources returned 8,147 papers, of which 3,083 were duplicates. From the remaining 5,064 papers, only 177 examined the effects of visual, verbal or combined manipulations on consumer responses as discussed above. I then applied the exclusion criteria which removed 119 papers, so the final dataset contained 58 papers.

Overview of Retrieved Data

The final dataset consists of 259 effect sizes (N = 23,060 participants) that were extracted from 132 experimental studies in 58 papers. These effect sizes were derived from both published (k = 216) and unpublished (k = 43) manuscripts. Specifically, they were extracted from experimental studies that elicited anthropomorphism through the presence of visual (k = 68), verbal (k = 85), or combined manipulations (k = 106) of the same target entity and compared its effects to a control condition without anthropomorphism. The experiments were conducted either in laboratory (57.14%) or online (42.86%) settings across different countries, including the United States, Australia, the United Kingdom, China (Mainland and Hong Kong), Germany, Indonesia, Italy, the Netherlands, and South Korea. The participants in these studies (M_{age} = 28.52, 51.33% female) were either students (63.52%) or non-student adults (36.48%). Finally, the target stimuli covered a wide range of consumption-based entities, including products, brands, service agents, and other entities (e.g., technology devices, social causes, resources, nature, and risk bearing entities).

Variable Coding

As illustrated in *Figure B2*, I examined several variables in my analysis. In this subsection, I address my categorisation decisions for each relevant variable, and propose the direction of their impact.

1) Type of Manipulation

The focal variable of the type of anthropomorphism manipulations was categorised into three types (i.e., visual vs. verbal vs. combined manipulations). I examined the impact of the type of manipulation on the overall effect size, in order to assess whether visual, verbal, or combined manipulations produced differential effects on consumer responses.

Specifically, studies that only used visual cues to suggest a target entity possesses a humanlike physical appearance were coded as 'Visual' (k = 68). The majority of studies in the sample implemented visual manipulations through the presence of humanlike facial features or bodily figures. Studies that only applied verbal information to describe/construe an entity's humanlike mind were categorised as 'Verbal' (k = 85). Moreover, given that there exist different types of verbal manipulations and scholars have speculated that they are associated with different degrees of anthropomorphising (Yang et al. 2020), I decomposed

verbal manipulations into two subgroups (i.e., verbal cues and verbal instructions) to further examine whether they produce differential effect on consumer responses. In particular, studies relying on cues describing an entity's humanlike mind, including personal pronouns, human names, identity, or agency, were coded as 'Verbal cues' (k = 58). In contrast, studies utilising instructions asking participants to imagine the target stimulus has come alive and to think about it as having a human personality or appearance, were coded as 'Verbal instructions' (k = 27).

For those studies manipulating anthropomorphism with both visual and verbal information within the same stimuli, I classified them into the 'Combination' category (k = 106). Among these 106 effects, only one used a combination of visual cues, verbal cues, and verbal instructions (Huang et al. 2019 - Study 1B), while the rest employed visual cues and verbal cues (without verbal instructions).

2) Type of Consumer Responses

Anthropomorphism may have different effects depending on the type of consumer responses assessed. Adopting the categorisation decision by Knoll and Matthes (2017), consumer responses can be classified into three types depending on which psychological dimension is triggered by marketing actions, which include affective, behavioural and cognitive. Affective responses are the result of marketers' effort to influence consumers' feelings and attitudes to a given product/brand. Behavioural responses are the result of marketers' efforts to influence consumers' actions. Cognitive responses are the result of marketers' efforts to influence consumers' knowledge and awareness of a specific product/brand. Hence, these types could reflect the different ways consumer responses are influenced by anthropomorphic marketing strategies.

While I do not make a prediction of which type of consumer responses would be affected the most or triggered by a specific type of manipulation, it is possible that they could be independently influenced by anthropomorphism manipulations to different degrees, because of the different stages of consumers' interaction with the anthropomorphised products that they represent. For example, some studies measured participants' actual or intended consumption decisions (i.e., behavioural responses) that are directly stimulated by anthropomorphism manipulations, while others only captured feelings or knowledge of products (i.e., affective or cognitive responses) without knowing whether participants desired to consume them.

Specifically, I coded responses in studies that utilised measurement items assessing participants' attitudes (e.g., towards products, Sivaramakrishan et al. 2007; towards brands, Puzakova 2012; Hart and Royne 2017; towards advertising, Hart and Royne 2017), evoked feelings (e.g., liking, Hur et al. 2015), and experienced affects (e.g., game enjoyment - Kim et al. 2016, desire strength - Hur et al. 2015) as 'Affective' (k = 67).

Next, I coded responses in studies that utilised measurement items pertaining to actual behaviours and behavioural intentions of purchasing, using or engaging with the target entities as 'Behavioural' (k = 87). For instance, product choice (e.g., Chen et al. 2017; Wan et al. 2017), purchase intention (e.g., Hart and Royne 2017; Kim 2019, Puzakova et al. 2013; Sivaramakrishan et al. 2007), or replacement intention (e.g., Chandler 2010; Chandler and Schwarz 2010) were classified as behavioural responses.

Lastly, responses in studies that utilised measurement items assessing participants' awareness and knowledge about the target entity were coded as 'Cognitive' (k = 105). These included: perception and judgment on the target entity (e.g., Kim and McGill 2011; Kim and Sandar 2012), evaluation (e.g., website's rationality, Sivaramakrishan, Wan and Tang 2007), brand recall (Hart 2013), trust (e.g., cognitive trust, Lee et al. 2015; Puzakova et al. 2013), and price estimation (e.g., Cooremans and Geuens 2019; Hur et al. 2015).

3) Conceptual Moderators

I considered several moderators that could affect the estimation of effect sizes of various anthropomorphism manipulations on consumer responses, including valence of responses, familiarity of the target entity, and the domain of entity.

The literature on anthropomorphism has shown that anthropomorphism manipulations can produce positive or negative consumer responses regarding a product (Aggarwal and McGill 2016). To capture the direction of anthropomorphic effects and gain better understanding on how consumers may relate to a target entity, I considered the moderating variable of 'Valence of responses' (i.e., approach and avoidance responses triggered by anthropomorphism manipulations). Given that consumer responses can be considered as either an approach or avoidance strategy that consumers apply (Higgins 2012; Kramer and Yoon 2007; Van Dessel, Hughes and Houwer 2018) when they interact with an anthropomorphic target entity, this variable provides an indication of the direction of overall consumer responses that are elicited by anthropomorphic stimuli. Specifically, I classified consumer responses that reflect consumers' desires and their motivation to approach the target entity as 'Approach' (k = 220). These included responses such as purchase intention

(e.g., Hart and Royne 2017; Kim 2019), choice (e.g., Wan et al. 2017), usage intention (e.g., Han et al. 2019; Ketron and Naletelich 2019) and brand considerations (Puzakova and Aggarwal 2018). In contrast, I coded the consumer responses that reflect participants' motivation to move away from the target entity as 'Avoidance' (k = 39), such as replacement intention (Chandler 2010) and the likelihood of them taking preventive steps against diseases (Wang, Touré-Tillery and McGill 2019). Since there might be a mixture of explanations behind the occurrence of anthropomorphic effects on approach and avoidance responses, I only considered their directional indications. That is, when controlling for this variable, approach responses would be expected to display positive effect sizes on consumer responses while avoidance responses would be expected to display negative ones.

Next, I also considered 'Familiarity' as one of my conceptual moderators, based on existing meta-analysis suggesting that anthropomorphism appeals are positively correlated with product evaluation when consumers are faced with high salience of uncertainty (Velasco et al. 2021). I thus expected that unfamiliarity of a target entity would yield greater effect sizes than familiar ones, because presenting an unfamiliar target object may also lead to a more engaged anthropomorphising process. To this end, those studies that designed anthropomorphic features on a well-known brand, or on products owned by participants, or on common abstract entities (e.g., nature, time, money) were coded as 'Familiar' (k = 86). Studies that anthropomorphised a fictitious brand/product were coded as 'Unfamiliar' (k = 173). In addition, for exploratory purposes, I used this variable to perform a subgroup analysis as previous research has suggested that situational factors such as familiarity can affect the effectiveness of visual and verbal information (Stiff et al.1989). Specifically, Stiff et al. (1989) argued that participants' judgments in familiar situations are mostly influenced by verbal information, while in unfamiliar ones they are influenced by both visual and verbal information. This pattern could potentially also exist in consumer responses influenced by familiar or unfamiliar anthropomorphised targets.

Lastly, I coded the moderator of 'Domain of entity', to consider the fact that some entities may be easier to perceive as anthropomorphised than others (Aggarwal and McGill 2007; Airenti 2018; Gray, Gray and Wegner 2007; Waytz et al. 2010). Among the collected anthropomorphism manipulations, the target entities were classified into four categories, including: products (k = 89), brands (k = 48), service agents (k = 11), and other (k = 111). Specifically, I categorised those studies using anthropomorphism manipulations on the target products as 'Product' (e.g., Chandler 2010; Hart 2013). Studies that anthropomorphised a target product but assessed its impact more broadly on the focal brand were categorised as

'Brand' (e.g., Kim 2019; Puzakova et al. 2013). Studies that relied on anthropomorphising an external entity embedded with the target product (e.g., target website embedded with anthropomorphised virtual salesperson acting as service agent, Sivaramakrishan et al. 2007; Fan et al. 2020) were coded as 'Service'. Finally, the 'Other' category covered a wide range of goods, including: resources (e.g., nature, time, money), risk bearing entities (e.g., slot machine, diseases), social causes that were used in environmental and prosocial campaigns, and technology devices (e.g., autonomous vehicle, digital assistants in experiential consumption). Note that the categorisation of technology devices in the 'Other' category rather than the 'Product' one stems from the fact that they are more likely to be anthropomorphised compared to the rest of products due to their higher perceived agency (Gray et al. 2007). Given that there is no clear-cut indication on which category of entities would be easiest to be perceived as anthropomorphised (Airenti 2018), I included this moderator to assess whether significant differences exist between them without speculating which one dominates ex-ante.

4) Other Moderators and Control Variables

Several variables were extracted as other moderators and control variables, including study characteristics (i.e., publication status), experimental setting (i.e., laboratory vs. online), methodological factor (i.e., measurement format), population characteristics (i.e., sampling, culture, and demographics of participants).

First, regarding publication status, since I collected effects from both published and unpublished studies, I coded those that were sourced from journal articles as 'Published' (k = 216), while those that were sourced from conference proceedings and PhD dissertations were coded as 'Unpublished' (k = 43). Prior research has considered that unpublished studies may not be able to produce strong enough effects to warrant journal publication (Rosenthal and Rosnow 2008; Weingarten and Goodman 2020). Considering this, I controlled for the status of the study, and expected that effect sizes from published articles would show greater overall consumer responses than from the unpublished ones.

Second, regarding experimental setting, I coded those studies that were conducted in a controlled laboratory setting as 'Laboratory' (k = 140). Studies that reported data collection from online panels (e.g., Mturk) were coded as 'Online' (k = 105). I considered experimental setting as a control variable. Due to the controlled environment of a laboratory setting, online studies would show considerably smaller effects than laboratory studies (Baumeister 2020). I thus expected that laboratory studies would yield greater effect sizes than online studies.

Third, since there is a wide range of consumer response measures, I further controlled for whether the reported effect sizes were captured by self-reported (k = 236) or observational (k = 23) measures. Specifically, studies that relied on self-reported consumer responses by participants themselves (e.g., through the use of Likert scales) were coded as 'Self-report'. Studies that relied on observational methods to capture consumer responses were coded as 'Observational' (i.e., those methods that relied on the experimenter to make quantitative judgments about consumer responses, such as counting the number of actual products participants selected in their baskets, Cooremans and Geuens 2019). Scholars have highlighted the discrepancy between self-reported measures and actual decisions which can be captured by observational measures (Holbrook 2011; Parry et al. 2021), yet, since there are no related findings in an anthropomorphism context, I did not make a prediction whether there are significant differences between self-reported and observational measures.

Lastly, I considered the population characteristics as control variables, including sampling (i.e., students vs. non-students), culture, and demographic of participants. More specifically, I categorised the participants into students versus non-students to assess whether there were systematic differences between them. In my sample, 10% of studies did not report their sampling in detail, but for those studies that reported this information, the majority utilised student samples (k = 148) while the rest used non-student samples (k = 85). In addition, the available geographic locations of participants (k = 150) were used to categorise them into 'Individualism culture' (k = 102) and 'Collectivism culture' (k = 48) in a similar way as coded by Velasco et al. (2021). As suggested by prior literature (Epley et al. 2007), collective culture participants would exhibit a greater propensity to anthropomorphise due to their need of affiliation to others, in contrast to individualism culture participants. I thus expected to observe this pattern in my sample. Finally, I also documented reported demographic information such as percentage of female participants and average age of sample per experiment to control for these factors.

Meta-Analytical Procedure

Effect Size Calculation

I used Cohen's *d*, or the standardised mean difference as the effect size metric to quantify the difference in consumer responses of participants between the experimental and control conditions. Since it is standardised, Cohen's *d* can be used to compare the results

from different studies. A positive Cohen's *d* indicates that the experimental condition induces stronger consumer responses than the control condition.

Among the calculated effect sizes, 40.54% utilised a one-way design including simple contrast (k = 71) and multiple contrasts (k = 34); while 59.46% utilised a factorial design (k = 154). In order to ensure that the collected effect sizes were consistent and were not confounded by conditional effects, I made the following computing decision for studies that employed factorial designs. Following Borenstein et al. (2009), I calculated the combined sample size, mean, and standard deviation across the conditions that were not the focus of my meta-analysis (i.e., non-anthropomorphism manipulations) such that I ended up with one set of sample size, mean, and standard deviation for the anthropomorphic group and another set for the non-anthropomorphic group. These statistics were then used to calculate Cohen's *d*. In this way, the calculated effect measured the impact of the anthropomorphism manipulation, ignoring the impact of the other manipulations. This ensured consistency across the calculated effect sizes because it measured the pure impact of the anthropomorphism manipulations.

In terms of effect size calculation, there were 155 effects that reported raw means and standard deviations of participants' responses in the anthropomorphised and the control conditions, which I used to calculate Cohen's *d* (including multiple factorial design studies). Eighty-six collected effects provided results from either *F*-test (k = 62), *t*-test (k = 22) or *z*-test (k = 1), in which case I transformed these test statistics into Cohen's *d* according to the formulas provided by Cooper, Hedges and Valentine (2009). Nineteen effects reported the Odds Ratio, i.e., success rate of the manipulation on affecting consumer responses, from which I calculated the Log Odds Ratio, and transformed this effect size metric into Cohen's *d*.

Several studies employed multi-item measures. This induces measurement errors, which can attenuate the estimation of the effect sizes (Cooper et al. 2009; Geysken et al. 2009; Grewal, Puccinelli and Monroe 2018; Hunter and Schmidt 2004; Wiernik and Dahlke 2019). Following Cooper et al. (2009), I corrected the effect sizes for measurement error by dividing them by the square root of the corresponding reliability measures. These include the reliability measures of both independent (i.e., manipulation checks on perceived anthropomorphism) and dependent (i.e., consumer response) constructs, as reported by Cronbach's alpha or the correlation coefficient of the items (Grewal et al. 2018). Studies that employed a single item to assess measurement constructs were assigned a reliability measure

of '1'. For the studies that did not report reliability measures, I used the average of all reported values across studies as suggested by Geysken et al. (2009).

Model Selection

This study utilised a random effects model, which assumes that the true effect sizes are distributed around a mean due to differences across studies regarding participants and treatments (Borenstein et al. 2009, 2010). This is in contrast to a fixed effects model where the true effect size is assumed to be a constant and the same across all studies. I chose the former model because it is more realistic in settings with heterogeneity across studies, which is likely to be the case in my sample that consists of studies utilising different interventions and outcome measures.

The most common application of random effects models assumes that effect sizes are independent of each other, which is reasonable when each study reports only one effect size. This model takes the form:

$$\hat{y}_i = \beta_0 + \zeta_i + \varepsilon_i$$

where $\hat{y}_i$ is the observable estimated effect size of study i, β_0 is the mean (overall) effect size to be estimated, $Var(\zeta_i) = \tau^2$ is the between studies variance which measures the heterogeneity between studies and $Var(\varepsilon_i) = v_i$ is the sampling variance of the study.

However, in my dataset several studies reported multiple effect sizes with correlated sampling errors (since they use the same set of participants). In addition, most papers contain several studies which may again induce correlation between effect sizes as the authors may use similar techniques and/or participants from the same subject pool across studies. As such, the independence assumption may not hold, which can result in deflated standard errors and an increase of Type 1 error (Hox et al. 2018). To overcome this issue, I thus utilised a multi-level meta-analytical model which allows the effect sizes to be nested within groups, each being assigned a different random effect. This specification has been recommended in the literature to deal with dependent effect sizes while retaining the sample size (Cheung 2014; Konstantopoulos 2011; McShane and Böckenholt 2018).

Specifically, I assume that effect sizes are nested within studies, and studies are nested within papers:

$$Level\ 1\ model: \quad \hat{y}_{ijz} = y_{ijz} + \varepsilon_{ijz}$$
$$Level\ 2\ model: \quad y_{ijz} = \kappa_{jz} + \zeta_{(2)ijz}$$

$$Level\ 3\ model: \quad \kappa_{jz} = \psi_z + \zeta_{(3)jz}$$
$$Level\ 4\ model: \quad \psi_z = \beta_0 + \zeta_{(4)z}$$

where in level 1 y_{ijz} is the unknown true effect size of effect size i in study j of paper z, $\hat{y}_{ijz}$ is its observable estimated value and $\varepsilon_{ijz} \sim N(0, v_{ijz})$ where v_{ijz} is the sampling variance of the effect size. In level 2 (effect size level) κ_{jz} is the average effect size of study j of paper z and $\zeta_{(2)ijz} \sim N(0, \tau^2_{(2)})$ where $\tau^2_{(2)}$ measures the heterogeneity between effect sizes i in study j of paper z. In level 3 (study level) ψ_z is the average effect size of paper z and $\zeta_{(3)jz} \sim N(0, \tau^2_{(3)})$ where $\tau^2_{(3)}$ measures the heterogeneity between studies j of paper z. In level 4 (paper level) β_0 is the mean (overall) effect size to be estimated and $\zeta_{(4)z} \sim N(0, \tau^2_{(4)})$ where $\tau^2_{(4)}$ measures the heterogeneity between papers z. The four equations above can be combined into one single equation:

$$\hat{y}_{ijz} = \beta_0 + \zeta_{(2)ijz} + \zeta_{(3)jz} + \zeta_{(4)z} + \varepsilon_{ijz}$$

In addition, it is possible to include moderator variables x which can explain the heterogeneity of the true outcomes:

$$\hat{y}_{ijz} = \beta_0 + \zeta_{(2)ijz} + \zeta_{(3)jz} + \zeta_{(4)z} + \sum_q \beta_q x_{ijzq} + \varepsilon_{ijz}$$

This is called a mixed-effects model where the random effects $\zeta's$ capture the variance of the true outcomes not accounted for by the moderator variables. I utilise this model to assess the impact of the moderators on consumer responses.

Since my dependent variable of interest, consumer responses, can be categorised into affective, behavioural and cognitive responses, it is possible to estimate separate overall effect sizes for each type of consumer response simultaneously by utilising a multivariate meta-analysis. In this way, I provide estimates for each type of response while preserving the sample size and capturing the correlations that might exist between them when using the same set of participants (Cheung 2019; Jackson, White and Riley 2020). In my sample 33% of studies included more than one type of consumer response, which justifies the selection of a multivariate model. Thus, by combining the multi-level with the multivariate model, it is possible to provide estimates for each type of response and take into account the dependence of effect sizes within and between studies. The model is estimated using the rma.mv() function of the "*metafor"* package in R (Viechtbaur 2010), which applies a restricted maximum likelihood (REML) estimator to estimate the model parameters. The REML estimator is preferred over full maximum likelihood because the latter induces a downward

bias on the variance estimation in multi-level regression modelling (Cinar et al. 2021; Hox et al. 2018).

Finally, in order to take into account potential model misspecification that could bias my results, I combine the previous methodology with the robust variance estimation (RVE) technique. The RVE methodology uses a working model of dependent effect sizes as the basis for parameter estimation. Hence, even in the presence of model misspecification, the meta-regression estimates will be unbiased with robust standard errors which increases their efficiency (Pustejovsky and Tipton 2021). Following Pustejovsky and Tipton (2021), I thus use the multi-level multivariate meta-analysis as the working model of RVE to make my results robust to model misspecification. The RVE estimation is implemented using the coef_test() function of the "*clubSandwich"* package in R.

Results

Focal Analysis

Results of Mean Effect Size

When analysing the full sample of effect sizes (k = 259), results from a multi-level model yielded a significant positive overall mean effect of anthropomorphism manipulations on consumer responses of d = 0.403 (95% CI [.204, .603], t = 4.05, p < .001). The Q-statistic (test for homogeneity) was significant, indicating that the between studies variance, τ^2 = .838, was statistically different from zero (Q (258) = 3590.94, p < .001), which is consistent with the assumption of the random-effects model. Moreover, the I^2 statistic (which quantifies the fraction of variability that is due to true heterogeneity rather than sampling error, Borenstein et al. 2017; Higgins et al. 2003; Higgins and Thompson 2002) was 96.99%, which indicated that a high proportion of variance was due to heterogeneity in true effects rather than sampling error. Furthermore, to understand the range of the distribution of true effect sizes around the mean value, I computed the prediction interval. The 95% prediction interval was -1.441 to 2.247, indicating a large variation of effect sizes across different studies.

Correction for Measurement Errors

After correcting for measurement errors, results from a multi-level model showed a slightly stronger overall mean effect of anthropomorphism on consumer responses of d = 0.469 (95% CI [.233, .706], t = 3.98, p < .001). Results from a heterogeneity test showed that

the between studies variance was $\tau^2 = 1.179$, which was statistically different from zero (Q (258) = 4242.82, $p < .001$). Similar to the analysis without correction for measurement errors, the I^2 statistic was 97.84%. The 95% prediction interval was also slightly broader compared to the uncorrected one, ranging from -1.718 to 2.657. Hence, after correcting for measurement errors, the results remained significant and similar in magnitude. I used the corrected effect sizes for all subsequent analyses.

Outlier Detection

Next, I tested for the presence of outliers in my sample that could have a disproportionate impact on the overall mean effect and induce the observed high heterogeneity as measured by the τ^2 statistic. I used the Cook's distance technique to diagnose outliers that is recommended for multi-level meta-analyses (Viechtbauer and Cheung 2010), which estimates the impact of each individual effect size on the fitted values of all other effect sizes simultaneously. Hence, the larger the distance value, the more disproportionate is the individual effect size's impact on the overall results, which would classify that individual effect size as an outlier. An effect size is deemed to have a significantly disproportionate effect if its Cook's distance value exceeds a critical value equal to the cumulative probability of the chi-squared distribution with p degrees of freedom where p equals the number of the model estimated parameters and probability equal to 50% (Viechtbauer and Cheung 2010). As can be seen in *Figure B3*, 10 individual effect sizes were shown to have a significant Cook's distance value and were removed in subsequent analyses.

After removing the outliers ($k = 249$), results from a multi-level model indicated a slightly reduced overall mean effect of anthropomorphism manipulations on consumer responses of $d = 0.425$ (95% CI [.231, .619], $t = 4.39$, $p < .001$). In addition, results from a heterogeneity test showed a decreased between studies variance of $\tau^2 = .720$ as expected, which was statistically different from zero (Q (248) = 3382.88, $p < .001$). The I^2 statistic was 96.60%, slightly lower than before. The 95% prediction interval was also slightly narrower compared to the one with outliers, ranging from -1.286 to 2.135. Hence, removing the outliers reduced the unexplained heterogeneity, so the subsequent analyses did not include outliers.

Model Evaluation

In order to justify my selection of the multi-level model compared to a standard random effects model, I performed a goodness of fit test by comparing the full four-level model with a restricted version where the between studies variances at levels 3 (study) and 4 (paper) were constrained to be zero. As can be seen in *Table B2*, the full model was a significantly better fit for the data, with AIC and BIC values lower than those for the restricted model, while the likelihood ratio test also indicated a significant difference between the two models (*LR* = 233.01, $p < .001$). Hence, in what follows, I utilised the four-level model to perform my analysis.

To provide further evidence for the existence of correlations within clusters, I broke down the between studies variance into the different levels. As can be seen in *Table B3* column 1, it was the largest in the paper level ($\tau^2_{\text{Paper}} = .326$) followed by the study level ($\tau^2_{\text{Study}} = .282$) and the effect size level ($\tau^2_{\text{Effect size}} = .112$). It is possible to estimate the correlation of the true effect sizes within each level by calculating the intraclass correlation (ICC) as the fraction of the between studies variance of each level divided by their total (Hox et al. 2018). In this way, $\text{ICC}_{\text{Paper}} = \frac{.326}{.720} = .453$ and $\text{ICC}_{\text{Study}} = \frac{.282}{.720} = .392$, which indicated that there was a significant correlation of effect sizes within study and paper levels. This further confirmed the selection of a multi-level approach to take into account the dependency of effect sizes.

Moderator Analysis

In order to assess the impact of type of manipulation on consumer responses, I included this variable as a moderator in a meta-regression and estimated three models with each type of manipulation as the baseline, respectively. When using visual manipulations as the baseline (see *Table B3* column 2), the overall between studies variance was $\tau^2 = .693$, which was statistically different from zero (Q (246) = 3286.70, $p < .001$). The I^2 statistic was 96.43%, slightly lower than before. As can be inferred by examining the intercept, visual manipulations had a significant overall mean effect, $\beta_0 = .345$ (95% CI [.071, .619], $t = 2.61$, $p = .016$). Verbal manipulations had a marginally statistically significant effect, $\beta_{\text{Verbal}} = .301$ (95% CI [-.008, .611], $t = 2.07$, $p = .056$), providing some evidence that verbal manipulations have a stronger effect on consumer responses compared to visual manipulations, in support of *H1*. In contrast, combined manipulations were not significantly different from visual

manipulations, $\beta_{Combination}$ = -.078 (95% CI [-.373, .217], t = -.54, p = .592), thus not supporting *H2*.

Next, I used verbal manipulations as the baseline (see *Table B4* column 2). The τ^2 and I^2 statistic remained the same, and verbal manipulations had a significant overall mean effect of β_0 = .646 (95% CI [.325, .968], t = 4.18, p < .001) as can be seen by the constant. Visual manipulations were marginally significantly different from verbal manipulations, consistent with the results using visual manipulations as the baseline, β_{Visual} = -.301 (95% CI [-.611, .008], t = -2.07, p = .056). Combined manipulations were significantly weaker than verbal manipulations, $\beta_{Combination}$ = -.379 (95% CI [-.683, -.076], t = -2.59, p = .016). This finding further indicated that *H2* was not supported, as the hypothesis implied that combined and verbal manipulations would have similar effects on consumer responses.

Finally, using combined manipulations as the baseline validated the previous findings (see *Table B5* column 2). Specifically, combined manipulations had a significant overall mean effect of β_0 = .267 (95% CI [.108, .426], t = 3.50, p = .002) as can be seen by the constant. Visual manipulations were not significantly different from combined manipulations, consistent with the results using visual manipulations as the baseline, β_{Visual} = .078 (95% CI [-.217, .373], t = .54, p = .592). Verbal manipulations were significantly different from combined manipulations, consistent with the results using verbal manipulations as the baseline, β_{Verbal} = .379 (95% CI [.076, .683], t = 2.59, p = .016). Overall, the results indicated that verbal manipulations induced a significantly stronger effect on consumer responses compared to visual and combined manipulations, while the latter two did not differ from each other.

Next, I further examined verbal manipulations by assessing whether the two types (verbal cues and verbal instructions) have a different mean effect size. The results are presented in *Table B4* column 3 using verbal cues as the baseline. As can be seen, the between studies variance reduced slightly to τ^2 = .681 while the I^2 statistic was 96.33%. Verbal cues had a significant overall mean effect of β_0 = .698 (95% CI [.283, 1.113], t = 3.57, p = .003). In addition, verbal cues produced no significant difference compared to verbal instructions ($\beta_{Verbal\ instructions}$ = -.173, 95% CI [-.972, .625], t = -.490, p = .635). However, there was a marginally significant negative effect of visual manipulations (β_{Visual} = -.343, 95% CI [-.717, .031], t = -1.98, p = .069), and a significant negative effect of combined manipulations ($\beta_{Combination}$ = -.439, 95% CI [-.824, -.055], t = -2.38, p = .027). Overall, the results indicated that verbal cues and verbal instructions did not have a differential impact on the overall mean

effect of consumer responses. In unreported results using verbal instructions as the baseline, there was no significant difference with visual or combined manipulations, which indicated that the stronger effect size of verbal manipulations compared to visual and combined ones was driven by verbal cues rather than verbal instructions.

Finally, I estimated meta-regressions including each additional moderator separately (see columns 4-6) and all moderators together (see column 7 of Table *B3*). As can be seen in columns 4-6, none of the moderators was significant. In other words, the studies did not show significantly different effects on consumer responses depending on whether they examined approach versus avoidance responses, different types of target entity (i.e., product vs. brand vs. service vs. other), or familiar versus unfamiliar target entities. Lastly, when including all moderators in column 7, the between studies variance was lower $\tau^2 = .679$, while the I^2 statistic was 96.29%. As can be seen from the constant, visual manipulations did not have a significant impact on the overall mean effect when including the additional moderators, $\beta_0 = .246$ (95% CI [-.114, .607], $t = 1.43$, $p = .169$). However, verbal manipulations remained significantly different from visual manipulations, $\beta_{Verbal} = .322$ (95% CI [.013, .631], $t = 2.22$, $p = .042$), while combined manipulations were not, $\beta_{Combination} = -.060$ (95% CI [-.395, .275], $t = -.37$, $p = .717$). Of the additional moderators, only familiarity was marginally significant, with studies designed with familiar target entities showing a lower overall mean effect than those with unfamiliar ones, $\beta_{Familiarity} = -.282$ (95% CI [-.602, .038], $t = -1.81$, $p = .081$). However, it is important to note that this only held true for the baseline studies, which when including all moderators referred to the ones that utilised visual manipulations for unfamiliar brands and measured approach responses. Despite this, the findings indicated that the difference between verbal and visual manipulations remained significant even after controlling for all moderators.

Additional Analysis with Control Variables

In the additional analysis, I considered additional control variables as mentioned in the previous section, publication status (published vs. unpublished), measurement format (self-report vs. observational), setting of study (laboratory vs. online), and population characteristics (student vs. non-student). I collected several demographic variables such as age, percentage of female participants in each study, geographical location of participants, and cultural background. However, there were missing data in each of these demographic control variables, which significantly reduced my sample size. While methods exist to impute

missing values, they require the assumption that they are missing at random (Cooper et al. 2009). This may not be the case in my dataset if, for example, researchers omit the age of participants or percentage of female participants in short report articles, as that would introduce a systematic bias in data reporting. Hence, I reported results on the remaining control variables in *Table B6*. As can be seen, the relative difference between verbal and visual manipulations was robust to the addition of the control variables (β_{Verbal} = .396, t = 2.54, p = .024), of which only publication status yielded a marginally significant result ($\beta_{Unpublished}$ = -.353, t = -1.98, p = .092), with unpublished studies reporting a lower effect on consumer responses compared to published ones.

Sensitivity Analysis

In this subsection, I performed a sensitivity analysis on the unobservable covariance matrix of individual effect sizes to ensure that my results are robust to different correlation assumptions. Specifically, the multi-level meta-analytical model assumes a block-diagonal covariance matrix where effect sizes within the highest level (paper level in my case) are correlated while effect sizes between papers are uncorrelated. I thus considered a range of different assumed correlations between effect sizes within papers and reran the model.

As can be seen in *Tables B7-B8*, the results remain quantitatively and qualitatively similar for correlations of 0.2, 0.5, and 0.8 compared to the main results discussed in the previous section for visual, verbal, and combination baselines. In general, the estimated parameters show a slight reduction as the correlation value increases. The between-studies variance also decreased significantly, although the I^2 statistic increased slightly. Nonetheless, the results reaffirmed the dominance of verbal manipulations compared to visual and combined ones.

Supplementary Analysis

1. *Multivariate Analysis*

In this subsection, I assessed the impact of the anthropomorphism manipulations on the three types of consumer responses, in order to gain further insights on which type was most likely to be affected by anthropomorphism manipulations and expand on my focal findings. Specifically, I utilised a multivariate multi-level meta-analysis to estimate the overall mean effect of each type (i.e., affective, behavioural and cognitive), while retaining

the sample size and taking into account the correlations that may exist between them. The results without moderators are presented in *Table B9* column 1.

As can be seen, the overall mean effects of anthropomorphism manipulations on each type of consumer response were all statistically significant, $d_{\text{Affective}} = 0.454$ (95% CI [.198, .710], $t = 3.58$, $p < .001$), $d_{\text{Behavioural}} = 0.269$ (95% CI [.055, .483], $t = 2.54$, $p = .015$), $d_{\text{Cognitive}} = 0.548$ (95% CI [.280, .815], $t = 4.12$, $p < .001$). Thus, anthropomorphism manipulations affected all three types of consumer responses. The between studies variance was $\tau^2 = .740$, slightly higher in magnitude compared to the multi-level model and statistically significant (Q (246) = 3304.71, $p < .001$), while the I^2 statistic was 96.65%. The 95% prediction intervals were also similar in range, from -1.256 to 2.164 for affective responses, from -1.441 to 1.979 for behavioural responses and from -1.161 to 2.256 for cognitive responses.

Next, for exploratory purposes, I included type of manipulation as a moderator. I first assessed the absolute impact of type of manipulation on type of consumer responses. This provides an overview of whether different types of manipulation affect consumer responses in different ways. The results are presented in *Tables B9-B11* column 2 for each type of manipulation as the baseline (visual, verbal and combined respectively), where the absolute impact is captured by the intercepts. As can be seen in *Table B9*, visual manipulations had a significant effect on affective ($\beta_{\text{Visual affective}} = .471$, 95% CI [.119, .824], $t = 2.86$, $p = .012$) and cognitive ($\beta_{\text{Visual cognitive}} = .386$, 95% CI [.001, .771], $t = 2.11$, $p = .049$) responses, but an insignificant effect on behavioural responses, ($\beta_{\text{Visual behavioural}} = .157$, 95% CI [-.174, .489], $t = 1.03$, $p = .322$). In *Table B10*, verbal manipulations had a significant effect on all types of consumer responses ($\beta_{\text{Verbal affective}} = .733$, 95% CI [.100, 1.367], $t = 2.56$, $p = .027$; $\beta_{\text{Verbal behavioural}} = .414$, 95% CI [.073, .755], $t = 2.55$, $p = .020$; $\beta_{\text{Verbal cognitive}} = .872$, 95% CI [.417, 1.326], $t = 4.12$, $p = .001$). Finally, in *Table B11*, combined manipulations had a significant effect on affective ($\beta_{\text{Combination affective}} = .240$, 95% CI [.001, .481], $t = 2.11$, $p = .050$) and cognitive responses ($\beta_{\text{Combination cognitive}} = .393$, 95% CI [.122, .664], $t = 3.04$, $p = .007$), but a marginally significant effect on behavioural responses ($\beta_{\text{Combination behavioural}} = .204$, 95% CI [-.040, .447], $t = 1.82$, $p = .093$). Overall, the findings indicated that verbal manipulations affect all types of consumer responses whereas visual and combined ones only affect affective and cognitive ones, with a marginal or insignificant effect on behavioural responses.

Second, to gain further insights on the focal results from the multi-level analysis, I examined the relative impact of type of manipulation on type of consumer responses. As can

be seen in *Table B10* column 2 using verbal manipulations as the baseline, there was a significant difference between verbal and visual manipulations for cognitive responses, $\beta_{\text{Visual cognitive}}$ = -.486 (95% CI [-.890, -.082], t = -2.68, p = .023), while the difference for affective and behavioural responses was not significant, $\beta_{\text{Visual affective}}$ = -.262 (95% CI [-.906, .382], t = -.85, p = .405), $\beta_{\text{Visual behavioural}}$ = -.257 (95% CI [-.665, .152], t = -1.32, p = .204). Further results in column 3 breaking down verbal manipulations into verbal cues and verbal instructions revealed that the significant difference in cognitive responses was driven by verbal cues rather than verbal instructions. These findings indicated that the dominance of verbal manipulations on consumer responses as argued in *H1* was specifically driven by their impact on cognitive responses.

Finally, looking at *Table B11* column 2 using combined manipulations as the baseline, there was no significant difference between combined and visual manipulations for any of the types of consumer responses, $\beta_{\text{Visual affective}}$ = .231 (95% CI [-.166, .628], t = 1.21, p = .240), $\beta_{\text{Visual behavioural}}$ = -.047 (95% CI [-.450, .357], t = -.24, p = .812), $\beta_{\text{Visual cognitive}}$ = -.007 (95% CI [-.435, .421], t = -.03, p = .972). In addition, there was a significant difference between combined and verbal manipulations for cognitive responses, $\beta_{\text{Verbal cognitive}}$ = .479 (95% CI [.038, .919], t = 2.30, p = .035), while the difference for affective and behavioural responses was not significant, $\beta_{\text{Verbal affective}}$ = .493 (95% CI [-.116, 1.103], t = 1.73, p = .105), $\beta_{\text{Verbal behavioural}}$ = .210 (95% CI [-.107, .527], t = 1.40, p = .181). These findings indicated that *H2* on the dominance of combined manipulations compared to visual ones was not supported for any of the types of consumer responses, consistent with the focal findings. Furthermore, the dominance of verbal manipulations compared to combined ones was driven by their impact on cognitive responses.

2. *Subgroup Analysis*

In subgroup analysis, I considered the differential impact of type of manipulation on separate subgroups as outlined in the conceptual moderator coding section above. Specifically, I split the sample according to the variable of familiarity to assess the relative effectiveness of visual, verbal and combined manipulations on consumer responses.

When looking at the subgroup containing studies with familiar target entities, neither verbal ($\beta_{\text{Familiar verbal}}$ = .030, t = .21, p = .842) nor combined ($\beta_{\text{Familiar combination}}$ = -.305, t = -1.21, p = .265) manipulations differed significantly from visual ones. However, studies with unfamiliar target entities exhibited stronger effects of verbal manipulations as compared to

visual ones ($\beta_{\text{Unfamiliar verbal}}$ = .503, t = 2.70, p = .029). Nevertheless, combined manipulations showed similar effects to visual ones ($\beta_{\text{Unfamiliar combination}}$ = -.004, t = -.02, p = .986). Hence, while Stiff et al. (1989) found that in familiar situations participants' judgments of a target would be primarily influenced by verbal information whereas in unfamiliar ones they would be influenced by both visual and verbal information, this pattern of results did not occur in my data. This is because when consumers were faced with familiar target entities, they did not report stronger responses when faced with verbal manipulations compared to visual ones, whereas when faced with unfamiliar targets, verbal manipulations induced stronger consumer responses compared to visual ones. Nonetheless, the results highlighted the dominance of verbal manipulations in promoting unfamiliar target products.

Publication Bias

In order to assess whether there is publication bias in the collected effect sizes, I ran a multi-level variant of Egger's test following Fernández-Castilla et al. (2021), as most publication bias detection techniques have not been extended to a multi-level context. This test aims to find evidence for the presence of small-study effects, i.e., for the presence of studies using a small sample and having a disproportionately large effect size. Specifically, I regressed the standardised effect sizes on the precision variable defined as the inverse of the effect sizes' standard errors as per the original Egger's test. However, the meta-regression included random effects at the effect size, study and paper levels to take into account the nested nature of my data. The test provides evidence for publication bias if the coefficient of the precision variable is significant. As an alternative to the inverse of standard errors, I used sample size as the precision variable following Fernández-Castilla et al. (2021) because standard errors are computed using effect sizes, which could induce a spurious correlation between the two.

When using the inverse of standard errors as the precision variable, the coefficient was not statistically significant, providing no evidence for publication bias, $\beta_{\text{Precision}}$ = -.054 (95% CI [-.129, .021], t = -1.72, p = .130). When using sample size as the precision variable, the coefficient was similarly not significant, $\beta_{\text{Precision}}$ = -.001 (95% CI [-.003, .001], t = -1.34, p = .201). Overall, the results of the two tests did not indicate the presence of publication bias.

Finally, I conducted a *p*-curve analysis. *P*-curve analysis aims to assess whether there is evidence of publication bias caused by selective reporting by examining the histogram of

p-values (Simonsohn, Nelson and Simmons 2014a, b; Simonsohn, Simmons and Nelson 2015). Specifically, if there is a true effect, very small p-values (e.g., with $p < .010$) would be more likely than larger p-values, leading to a right skew of the *p*-curve. On the other hand, if selective reporting occurs, one would expect those analyses producing *p*-values that are close to but below the threshold significance level (e.g., .050). In other words, there would be an over-representativeness of *p*-values close to the threshold, producing a left skew.

In order to conduct *p*-curve analysis, I selected *p*-values following the guide of Simonsohn et al. (2014a). The results are presented in *Figure B4*. As can be seen, the figure shows a right skew, with 40% of studies having a *p*-value of less than .010 while only 14% of studies have a *p*-value between .040 and .050, which provided support for the presence of a true effect. This was further supported when using the binomial test examining the proportion of *p*-values above or below the threshold ($p < .001$), and two continuous tests using the full *p*-curve ($z = -10.69$, $p < .001$) and the half *p*-curve ($z = -11.10$, $p < .001$). Overall, the analysis provided evidence for the presence of a true effect rather than selective reporting driving my results.

In summary, the analysis of this section suggested that small-study effects and selective reporting cannot fully explain the current findings, indicating the presence of a true effect.

General Discussion

Key Findings

Using a multi-level meta-analysis of 249 effect sizes derived from 130 studies in 58 papers utilising anthropomorphism manipulations on consumer responses ($N = 22{,}951$), I found a significant overall effect ($d = 0.425$). This finding suggests that the design of anthropomorphic marketing stimuli has a positive impact on consumer responses, which is consistent with previous meta-analytical studies (Blut et al. 2021; Velasco et al. 2021).

My research expands on previous findings by considering the relative effectiveness of various anthropomorphism manipulations on a broad range of consumer responses. Utilising a multi-level meta-regression to test the moderating impact of the type of manipulation, the results indicated that verbal manipulations induced the strongest effect on consumer responses ($d_{Verbal} = 0.646$), followed by visual and combined manipulations which showed statistically similar effects ($d_{Visual} = 0.345$, $d_{Combination} = 0.267$). This pattern of results is consistent with the arguments in human-to-human communication literature that the presence

of a humanlike mind would induce stronger evaluation of the targets compared to the presence of biological life (Gesn and Ickes 1999; Hall and Schmid Mast 2007; Schroeder and Epley 2015; Schroeder and Epley 2016; Schroeder, Kardas, and Epley 2017), and expands them in the context of product anthropomorphism by validating speculative arguments that different scholars have made (Golossenko et al. 2020; Kim and McGill 2011; 2018; MacInnis and Folkes 2017; Yang et al. 2020). In addition, given the widespread use of combined manipulations, there is scant evidence on their relative effectiveness in influencing consumer responses compared to visual and verbal ones. My findings provide new knowledge which differs from the arguments and findings in the human-to-human communication and advertising literature which maintain that combined manipulations show similar effects to verbal ones. Instead, my findings suggest that combined manipulations influence consumer responses to the same extent as visual manipulations, but to a lesser extent than verbal ones.

Next, breaking down consumer responses into three types defined as affective, behavioural and cognitive responses, the results suggested that anthropomorphism manipulations produce positive effects on all types of responses ($d_{\text{Affective}} = 0.454$, $d_{\text{Behavioural}} = 0.269$, $d_{\text{Cognitive}} = 0.548$). Extending the meta-analysis to a multivariate context, the results showed that the dominance of verbal manipulations was mainly observed on cognitive responses. Furthermore, when examining the effect of each anthropomorphism manipulation individually on each type of consumer response, the results indicated that verbal manipulations consistently produce a significant effect on all types while visual and combined manipulations had only a marginal or insignificant effect on behavioural responses. This finding further solidified the superiority of verbal manipulations in eliciting positive consumer responses irrespective of their type.

To further draw insights on the dominance of verbal manipulations compared to visual and combined ones, I performed a subgroup analysis for studies employing familiar or unfamiliar target entities. While prior research found that in familiar situations participants' judgments of a target would be primarily influenced by verbal information, whereas in unfamiliar ones they would be influenced by both visual and verbal information, this was not the case for the relative effectiveness of visual and verbal manipulations in consumer responses when eliciting anthropomorphism. Specifically, I found that when participants were faced with familiar target entities, they did not report stronger responses when faced with verbal manipulations compared to visual ones, while when faced with unfamiliar targets, verbal manipulations induced stronger consumer responses compared to visual ones.

Nonetheless, the results highlighted the dominance of verbal manipulations in promoting unfamiliar target products.

Lastly, publication bias was tested using a multi-level variant of the Egger's test as well as *p*-curve analysis. The analysis did not find evidence for the presence of publication bias, thus indicating the presence of a true effect of anthropomorphism on consumer responses.

Overall, the current chapter provides several novel insights to the extant literature of anthropomorphism. First, the findings empirically showed that different anthropomorphism manipulations affect consumer responses in different ways, which allows researchers to understand how these manipulations may affect consumer responses as well as their differential effectiveness. Second, the findings provide a systematic overview of the effects of anthropomorphism manipulations on various types of consumer responses in a unified framework that takes into account their interdependencies, shedding light on the potential way to design the most effective anthropomorphism manipulations to optimise consumer responses.

Theoretical Implications

Prior research has relied on a variety of approaches to manipulate anthropomorphism and has found a mixed pattern of effects on consumer responses. Noticing this, scholars have reiterated the importance of gaining a deeper understanding of the way various anthropomorphism manipulations affect consumer responses (Epley 2018; Yang et al. 2020), but little empirical evidence exists examining this. Two meta-analyses have been conducted to assess the effects of anthropomorphism on consumer responses, but they did not conceptually differentiate the various anthropomorphism manipulations and assess their impact on all existing consumer responses. Furthermore, while scholars have extensively used combined manipulations in the literature, there is scant discussion on whether they can improve consumer responses compared to their individual components. To provide clarity on the effectiveness of anthropomorphism manipulations in influencing consumer responses, I evaluated the individual impact of visual, verbal and combined manipulations on consumer responses and documented their differential effects.

The current chapter has several theoretical implications. First, the findings contribute to the discussion on the effectiveness of anthropomorphism manipulations (Epley 2018; Yang et al. 2020). While the literature has agreed that the deepest level of anthropomorphising resonating with consumers occurs with the attribution of a humanlike mind, whether this is

achievable by all manipulations remains untested (Epley 2018). In addition, Yang et al. (2020) have questioned the interchangeable use of anthropomorphism manipulations and proposed a continuum viewpoint that various manipulations may elicit anthropomorphism to different degrees, but few suggestions have been made concerning their impact on consumer responses. To this end, the current findings supported the theoretical argument that verbal manipulations elicit a deeper perception of anthropomorphism by showing they lead to stronger consumer responses compared to visual manipulations.

Considering the stronger effect of verbal manipulations on consumer responses compared to visual ones, it is plausible that the different processing of visual and verbal information of anthropomorphised targets also contributes to the observed effects. Scholars have argued that visual and verbal manipulations may lead to a possible dual mode of information processing of the anthropomorphised targets, depending on how those humanlike features are displayed (Kim and Sandar 2016; Lee et al. 2015). For instance, Lee et al. (2015) speculated that visual manipulations displayed explicit information about a target entity's physical appearance which is concrete and explicit, triggering a "heuristic (immediate and peripheral) processing". In contrast, verbal manipulations signalling a humanlike mind require conscious elaboration, triggering a "systematic (rational and analytic) processing". Therefore, consumers' response to the anthropomorphised targets could be a manifestation of the different processing style of visual versus verbal information, whereby the more prominent effect of verbal manipulations reflects a 'cognitive elaborated state of mind' of participants (Lee et al. 2015). Perhaps for this reason, the use of visual manipulations to anthropomorphise multimedia learning materials has been labelled as a type of emotional design to influence learners' affect, behaviour and cognition (Brom, Stárková and D'Mello 2018; Uzun and Yildirim 2018), which requires a minimal effort from learners to be perceived. On the other hand, encoding verbal information is also considered as a systematic process: to receive and comprehend verbal representations, it may require the additional formation of mental imagery by participants (i.e., dual coding theory: Kirby 1993; Luna 2005; Mousavi et al. 1995). Consequently, the effortful elaboration of verbal information can possibly facilitate a strengthened recall of message (Auble and Franks 1978; Tversky 1973), cognitive trust (Lee et al. 2015), or even extend to a more enduring attitudinal or behavioural change (Petty and Cacioppo 1986; Sela et al. 2012). Given this, in my context, it is possible that visual manipulations signal the presence of humanlike physical appearance of the target, but also reflect the automatic information processing by participants. In contrast, verbal manipulations signal the presence of humanlike mind of target products, and the dominant

observed effects may also reflect a more elaborated information processing by participants. This could explain my finding that the dominance of verbal manipulations is mainly observed in cognitive responses.

Furthermore, the difference in verbal and visual information processing could also explain the weaker effects of combined manipulations on consumer responses compared to verbal ones. Prior research has suggested the visual redundancy effect in combined manipulations, i.e., that visual information does not facilitate a greater inference of a targets' humanlike mind, to explain why they exhibit similar effects to verbal ones as regards judging the mental capacities of targets (Gesn and Ickes 1999; Hall and Schmid Mast 2007; Schroeder and Epley 2015). However, my findings indicate weaker effects of combined manipulations compared to purely verbal ones, but similar effects compared to visual ones, which suggests a visual primacy explanation. Specifically, prior research suggested that in a conjoint usage of visual and verbal information within the same stimuli, the visual element is superior to the verbal one in affecting people's formation of a social attitude, because visual information switched participants' attention away from verbal information (DePaulo et al. 1978; Howe 1989; Stiff et al. 1989). Moreover, Howe (1989) showed that the visual primacy effect was caused by the verbal information in combined manipulations being perceived as 'contextually inappropriate', which in turn drove people's attention towards the visual information. Thus, it is possible that in a combined manipulation, visual signals of the presence of humanlike physical appearance switched participants' attention away from verbal information, or even made participants perceive verbal signals of a humanlike mind as unnatural.

Future research could directly examine the fit of different manipulations with different approaches to information processing. As suggested by Wyer Jr. et al. (2008a, b), individual differences in processing information visually or verbally, or situational factors that might affect which processing strategy is used, could have an impact on consumer responses depending on whether the anthropomorphism manipulation matches their utilised strategy. Following this, I suggest that future research designs visual, verbal and combined manipulations in the same study, and tests whether these different anthropomorphism manipulations lead to variation in processing these stimuli (e.g., response time to various manipulations or processing fluency; Wyer Jr. et al. 2008a, b). In addition, several moderators can be considered when examining the differential effects of visual, verbal and combined manipulations from the current findings. These include individual differences in processing information visually or verbally (e.g., visualiser vs. verbaliser) or situational

factors (e.g., pleasant vs. unpleasant situations where anthropomorphised products are displayed).

Practical Implications

The current chapter offers several practical implications. First, findings from this chapter can help companies and practitioners that aim to optimise the design of anthropomorphic marketing stimuli to influence consumer responses. Specifically, based on the findings that verbal manipulations are superior to visual and combined ones, companies should consider using the former to maximise the consumer responses. Moreover, the current chapter found that combined manipulations do not elicit stronger effects compared to visual and verbal ones, hence, when designing anthropomorphic marketing stimuli, it should be borne in mind that more features do not always yield better results.

Furthermore, when considering at which stage to promote anthropomorphised products on the consumer journey (i.e., awareness, consideration, or conversion stages), my findings indicated that verbal manipulations consistently produced a significant effect on all types of consumer responses, while visual and combined manipulations had a marginal or insignificant effect on behavioural responses. Thus, it is preferrable to display verbal manipulations at the decision-making stage (i.e., conversion) which is a behavioural action.

Lastly, my findings from subgroup analysis suggested a differential effect of anthropomorphism manipulations when used on unfamiliar target entities as opposed to familiar ones. That is, verbal manipulations were stronger than visual ones only when participants faced unfamiliar entities, but similar when consumers were faced with familiar target entities. This finding suggests that companies should consider employing the verbal dominant effects during new product launching.

Limitations and Future Research

The current study tested the relative effectiveness of various anthropomorphism manipulations. Nonetheless, there were certain limitations that future research should address. First of all, within the same type of anthropomorphism manipulations, there may exist differences in the degree of anthropomorphism (i.e., subtle vs. overt, Reavey et al. 2018). For instance, within visual manipulations, subtle versus overt display of anthropomorphism manipulations may exist (e.g., the direct placement of faces on target objects vs. using arranged geometric elements to resemble a humanlike face or eyes; Huang

et al. 2019; Hur et al. 2015; Kim and McGill 2011; Tam et al. 2013). Studies using verbal cues may also exhibit a variation in their degree of signalling anthropomorphism (e.g., describing objects with humanlike intentions and agency vs. using personal pronouns making interpersonal norms salient; Kim and McGill 2011; Puzakova et al. 2013). Prior research has shown that subtle anthropomorphism manipulations will lead to more positive attitudes to advertisements compared to overt ones when consumers are not cognitively busy, but this pattern of results reverses when they are cognitively busy (Reavey et al. 2018). Despite acknowledging this possibility, it remains a challenge to categorise manipulations accordingly to assess whether they produce different effects, because perceiving anthropomorphism manipulations as subtle or overt may vary across participants. Future studies should extend the current findings, by distinguishing between subtle and overt manipulations and experimentally testing their impact on consumer responses.

Second, as noted in the exclusion criteria section, there were some types of manipulation and consumer responses underrepresented in my sample and therefore not included in my meta-analysis. Regarding the type of manipulation, very few papers have relied on other types such as vocal manipulations and dynamic visual movements. While the extant research has associated vocal manipulations with the presence of humanlike mind (Watyz et al. 2014), it is unclear whether vocal versus verbal manipulations exhibit similar effectiveness in affecting consumer responses. Future meta-analytical research could extend the current findings, by including these types of manipulation when more studies become available. Moreover, my findings speak only to the immediate responses of consumers to anthropomorphism stimuli rather than to longer-term ones, as I did not include the studies that used a longitudinal experimental design due to their small number and the different modelling techniques required.

Third, although in the current meta-analysis I intended to control for culture of participants and explore its impact on the effect of anthropomorphism manipulations on consumer responses, I omitted this relevant variable due to the significant amount of missing data. Future research should consider the potential impact on consumer responses of other antecedents of anthropomorphism (i.e., effectance motivation and sociality motivation that are facilitated by situational factors or consumer characteristics, Epley et al. 2007).

Conclusion

Extensive research has suggested that anthropomorphising products or brands affects consumer responses toward these targets. As a result, the effects of anthropomorphism on consumer responses have received considerable attention by researchers. However, given the existence of significant heterogeneity of approaches to the manipulation of anthropomorphism, as well as their mixed findings as regards its effects, scholars have reiterated the importance of both clarifying these effects and further evaluating these manipulations. Various suggestions have been made to consider the possible differences among anthropomorphism manipulations in eliciting anthropomorphism, but there is a lack of consensus or empirical assessment to clarify their relative effectiveness in influencing consumer responses.

To address this, my research systematically evaluated the effectiveness of various anthropomorphism manipulations in influencing consumer responses. Utilising a multi-level meta-analysis, I found that the presence of anthropomorphism manipulations leads to positive consumer responses. More specifically, I found that verbal manipulations were more effective in influencing consumer responses than visual and combined ones, whereas the latter two showed similar, but weaker, effects. Extending my meta-analysis to a multivariate context, I found that that the dominance of verbal manipulations was driven by cognitive responses. Taken together, the current findings robustly strengthened the argument in favour of the superiority of verbal manipulations in eliciting positive consumer responses.

This research offers several contributions. Theoretically, the current chapter provides conceptual clarity on the effectiveness of anthropomorphism by contributing to the discussion on whether its different facets can influence consumer responses to varying degrees. Methodologically, the current meta-analysis conceptually differentiates the various anthropomorphism manipulations and assesses their impact on all existing consumer responses. The multi-level multivariate approach provides accurate estimations of overall effect sizes for different types of consumer responses within the same analysis, helping researchers in the field to have better predictive power on consumer responses. Practically speaking, the study results can benefit marketing practitioners by providing guidance on how to design and devise the anthropomorphism marketing stimuli in the absence of ex-ante knowledge of which type of anthropomorphism manipulations will be most effective in affecting their consumers.

Chapter 4

Conclusion

Given the ubiquity of anthropomorphism in consumers' daily life, consumer research on anthropomorphism has proliferated, yet work on the conceptualisation and theoretical development of this construct is still ongoing. Several important questions in the field remain open, including the extent to which different anthropomorphism manipulations effectively elicit anthropomorphism and whether they are able to influence consumer responses.

This thesis has contributed to addressing these key questions by systematically examining the impact of existing anthropomorphism manipulations on the elicitation of anthropomorphism (*Chapter 2*) and downstream consumer responses (*Chapter 3*). More specifically, in *Chapter 2*, I contribute to the debate on the ways that anthropomorphism is elicited. While some scholars have argued that it is triggered solely by the perception of a humanlike mind (Epley 2018; Waytz et al. 2010), others have argued that it is jointly triggered by the perception of a humanlike physical appearance and a humanlike mind (Golossenko et al. 2020; Ruijten et al. 2019), or by either of those two dimensions but with different intensity (Yang et al. 2020). I propose an alternative framework considering the possibility that the two key dimensions of anthropomorphism are distinct from each other and that they represent different facets of it; that is, each of them produces individual effects that represent a subset of anthropomorphism. I then map these two key dimensions onto their corresponding manipulation methods and measures and argue that visual and verbal manipulations elicit the perception of a humanlike physical appearance and a humanlike mind respectively.

Findings from three pre-registered experimental studies and a meta-analysis indicated that visual manipulations heighten the perception of a humanlike physical appearance while verbal manipulations heighten the perception of a humanlike mind. The results indicated that both key dimensions are sufficient to trigger anthropomorphism, in contrast to the argument that a perception of humanlike mind is the necessary and sufficient condition to trigger this construct. Moreover, in contrast to the current multidimensional viewpoint that humanlike physical appearance and humanlike mind reflect the same true underlying concept that the focal construct represents, my findings indicated that they instead represent different facets of it, since the efficacy of visual and verbal manipulations in eliciting anthropomorphism depended on their conceptual distance from the dimensions they are meant to induce.

In *Chapter 3*, I contribute to the literature by assessing the differential effects on visual, verbal and combined manipulations on consumer responses. Previous research has documented a mixed pattern of results of anthropomorphism on consumer responses, and few suggestions have been made as to whether the different manipulations can lead to differential

effects on consumer responses. Some scholars have speculated that the association of the visual and verbal manipulations with different facets of anthropomorphism could have an impact on their ability to influence consumer responses, but it is not clear what the effect might be (Yang et al. 2020). In addition, while scholars have extensively used combined manipulations in the literature, there is scant discussion on whether they can improve consumer responses as compared with their individual components.

Given the lack of predictions in the anthropomorphism literature, I build on the human-to-human communication and advertising literature and predict that verbal manipulations would elicit stronger consumer responses than visual ones because the former convey the entity's mental state, leading to a stronger evaluation of these products as compared to when visual ones were used. Moreover, I predict that combined manipulations will elicit stronger consumer responses compared to visual ones because of the visual redundancy effect, i.e., that visual information does not facilitate a greater inference about a targets' humanlike mind.

Utilising a multi-level meta-analytical approach, I found that the presence of anthropomorphism manipulations leads to positive consumer responses. More specifically, I found that verbal manipulations were more effective in eliciting consumer responses than visual and combined ones, whereas the latter two showed similar effects. In other words, while the first prediction was validated, the second one was not. Prior research has suggested the visual redundancy effect in combined manipulations as a way to explain why they exhibit similar effects to verbal ones when judging the mental capacities of targets (Gesn and Ickes 1999; Hall and Schmid Mast 2007; Schroeder and Epley 2015). In contrast, my findings could potentially point to an explanation of visual primacy effect. That is, in a conjoint usage of visual and verbal information to promote anthropomorphised products, the visual element could switch participants' attention away from verbal information, which would weaken the impact of combined manipulations on consumer responses as compared to the verbal ones.

Taken together, this thesis contributes to the literature by showing that anthropomorphism can be elicited through distinct routes linked to its dimensions, and that various manipulations can have differential effects on consumer responses. This provides clarity on the construct of anthropomorphism and how consumers relate to its different facets.

Theoretically, my findings invite a reflection on the construct validity of anthropomorphism. Specifically, it is possible that anthropomorphism is a multidimensional formative construct whose dimensions are its defining characteristics that determine what it entails. This is a fruitful area for future research. Furthermore, my findings directly speak to

the call by Epley (2018) and Yang et al. (2020) to clarify the way different anthropomorphism manipulations may lead to different consumer responses. Future research can consider the impact of different approaches to information processing on visual and verbal manipulations in order to understand whether they play a role influencing the way participants interact with anthropomorphised products.

Practically, the findings provide insights to practitioners on how to design product and brand strategies to successfully elicit anthropomorphism and thus achieve desirable consumer responses. Specifically, practitioners should acknowledge the association of visual and verbal manipulations with the key dimensions of humanlike physical appearance and humanlike mind respectively, and design marketing campaigns accordingly. In addition, the dominance of verbal manipulations over visual ones suggests that designing anthropomorphism strategies conveying a target entity's mental state can induce stronger consumer responses than those conveying its humanlike physical appearance. Finally, the weaker effect of combined manipulations compared to verbal ones suggests that adding multiple cues does not necessarily lead to stronger consumer responses and can even weaken the individual effect of verbal manipulations.

Appendices

Appendix A: Chapter 2

1. Mapping existing manipulations based on key dimensions of anthropomorphism

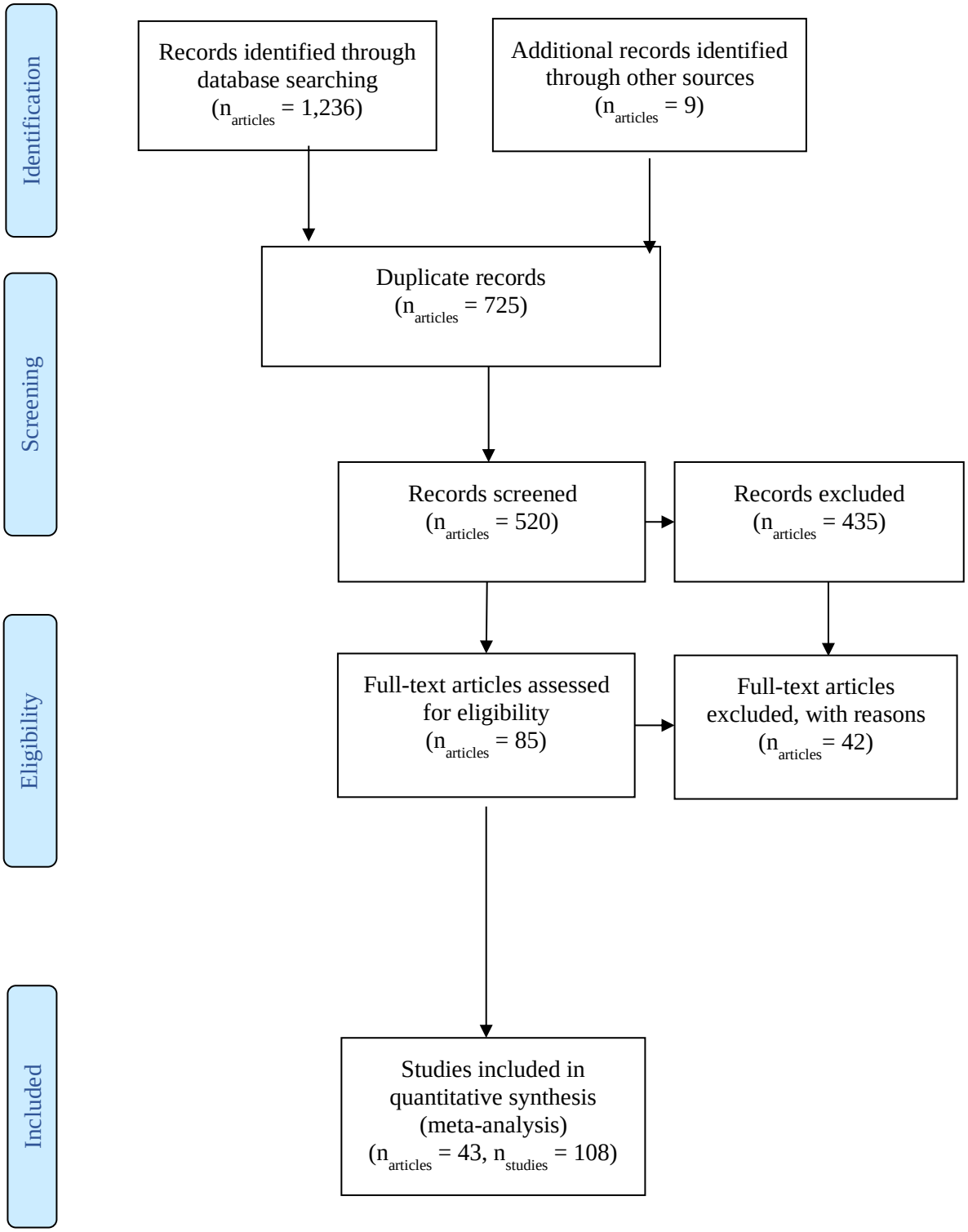
Table A1. Mapping of manipulations based on dimensions of anthropomorphism

Form of manipulations	Visual Manipulations	Verbal Manipulations	
		Verbal cues	Verbal instructions
Definition	The presence of visual cues to attribute humanlike physical appearance to the target products	The presence of verbal information describing products possessing humanlike mind	The presence of verbal information guiding participants towards thinking about target products of the concept of humans
Examples	• Facial features: - Attributing faces on objects, e.g., Tam et al. 2013- Study 3; Hur et al. 2015- Study 1 - Using an assortment of geometric features resembling faces or eyes, e.g., Kim and McGill 2011 – Study 1; Huang et al. 2019-Study 3B, Study 4 • Body figures: Imbuing limbs that resemble a human body, e.g., Awad and Youn 2018-Study 1; Huang et al. 2019- Study 1B; Schneider et al. 2019- pilot study • Displaying an object as if it has humanlike behaviour, e.g., Puzakova et al. 2013- Study 1B; Koo, Oh and	• Using first person pronoun, such as the use of "*I*", "*we*", "*you and I*", e.g., Aggarwal and McGill 2007-Study 1; Hur et al. 2015-Study 2; Newton et al. 2017- Study 2; Wan et al. 2017-Study 3 • Giving an identity to products or personalities, e.g., *"We are the Maxco Charger family! We will be trusted partners on your journey*" (Wan et al. 2017- Study 3) "*a great ally*" (Touré-Tilley and McGill 2015- Study 1). "*I am the best, nobody can compare*" (Awad and Youn 2018- Study 1)	• Study instruction asking participants to think of an entity comes alive as human, e.g., Aggarwal and McGill 2012; May and Monga 2014- Study 2 Follow Up study and Study 4; Wan et al. 2017- Study 4; Zhou et al. 2018- Study 2 Additional Study and Study 4 • The display of verbal information that indicates human qualities: - Use of humanlike personality as bipolar measures to prime participants thinking of product with human concepts: e.g., By asking participants to rate their owned cars among a set of bipolar scale anchored with personality traits in anthropomorphic condition, e.g., "*reserved-enthusiastic*", in contrast to mechanical objectified

	Patrick 2019-Study 2	• Suggesting target products has its own intentions, goals, and agency, e.g., "*I am your credit card assistant. I know what you need"* (Puzakova, Rocereto and Kwak 2013-Study 1,2) "*The slot machine can decide whether you will win or lose a series of bets anytime she wants. Sometimes, she may choose to make fun of you*." (Riva et al. 2015-Study 1-4)	attributes "*quiet-loud*" in control condition (Chandler 2010; Chandler and Schwarz 2010) - Describing target product with agentic framings in rating questionnaires in anthropomorphic condition, instead of a neutral framing in control condition (Mourey et al. 2017) e.g., "How would you rate how well *your phone does the work*" (Anthropomorphic condition) vs. "How would you rate *the functionality of your phone*" (Control condition)

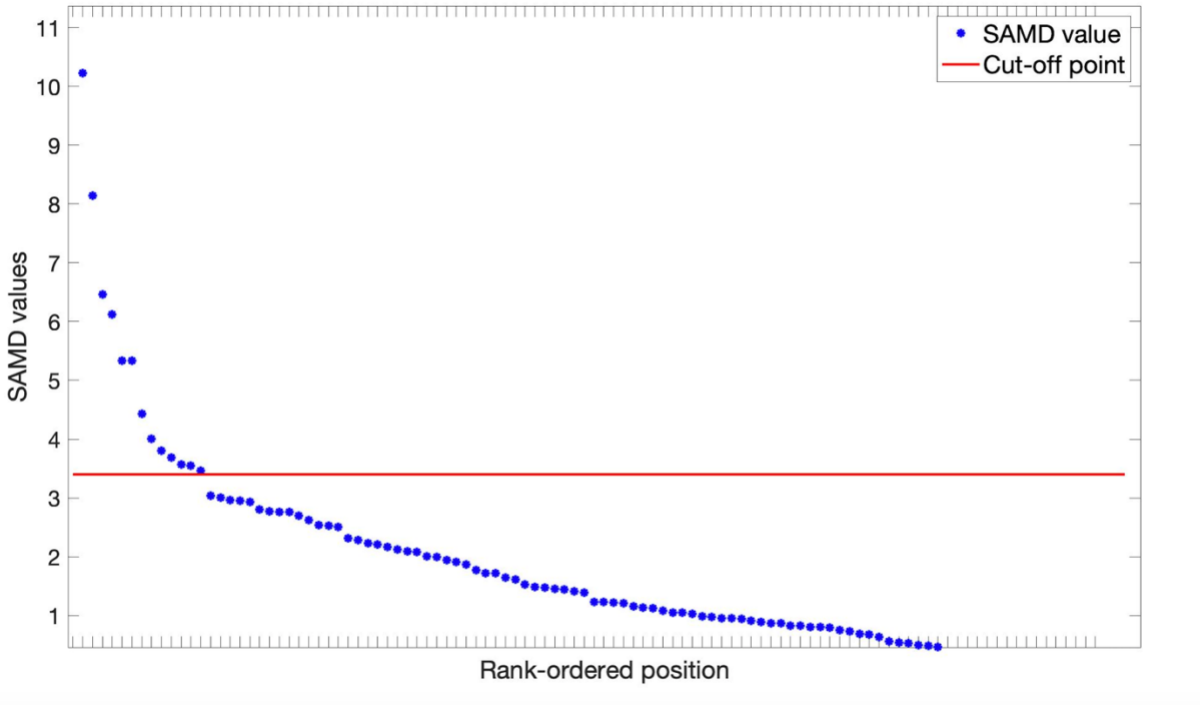
2. Flow diagram for data collection

Figure A1. Flow diagram for literature search procedures (adapted from PRISMA protocol)



3. Outlier detection

Figure A2. Scree plot analysis for sample-adjusted meta-analytic deviancy (SAMD) statistics



4. Results from meta-regression models

Table A2. Meta-regression results: visual baseline

	(1)	(2)	(3)	(4)	(5)	(6)
Verbal	−.071	−.221**			−.203*	
	(−.82)	(−2.32)			(−1.86)	
Combination	−.034	.052	−.035	.075	.094	.112
	(−.40)	(.61)	(−.45)	(.91)	(.97)	(1.17)
Verbal cues			−.043	−.129		−.093
			(−.46)	(−1.38)		(−.87)
Verbal instructions			−.133	−.268**		−.289**
			(−1.31)	(−2.54)		(−2.47)
Matching		.281***		.263***	.269***	.269***
		(3.03)		(3.02)	(2.61)	(2.83)
Measurement item objective					−.043	−.030
					(−.36)	(−.26)
Measurement item objective & subjective					−.135	−.141*
					(−1.64)	(−1.73)
Assessment technique					.106	.113
					(1.36)	(1.46)
Type of design					−.016	−.008
					(−.23)	(−.11)
Site of study					.027	.051
					(.37)	(.69)
Constant	.827***	.722***	.828***	.699***	.710***	.666***
	(11.76)	(9.79)	(13.10)	(9.66)	(7.83)	(7.66)
N	94	94	94	94	90	90
τ^2	.046	.037	.046	.036	.042	.039
$I^2(\%)$	58.45	52.70	58.21	52.10	55.09	53.57
$R^2(\%)$	.00	16.89	.00	18.42	10.67	15.62

z-statistics are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Table A3. Meta-regression results: verbal baseline

	(1)	(2)	(3)	(4)	(5)	(6)
Visual	.071	.221**	.032	.175*	.203*	.145
	(.82)	(2.32)	(.34)	(1.77)	(1.86)	(1.30)
Combination	.037	.272***	−.002	.233**	.298***	.243**
	(.55)	(2.66)	(−.02)	(2.23)	(2.61)	(2.11)
Verbal instructions			−.100	−.146		−.199*
			(−.97)	(−1.51)		(−1.93)
Matching		.281***		.301***	.269***	.310***
		(3.03)		(3.25)	(2.61)	(3.01)
Measurement item objective					−.043	−.052
					(−.36)	(−.44)
Measurement item objective & subjective					−.135	−.135*
					(−1.64)	(−1.66)
Assessment technique					.106	.111
					(1.36)	(1.45)
Type of design					−.016	−.022
					(−.23)	(−.32)
Site of study					.027	.047
					(.37)	(.66)
Constant	.756***	.501***	.794***	.539***	.507***	.543***
	(15.10)	(5.20)	(12.43)	(5.46)	(4.20)	(4.53)
N	94	94	94	94	90	90
τ^2	.046	.037	.046	.036	.042	.039
$I^2(\%)$	58.45	52.70	58.24	51.60	55.09	52.99
$R^2(\%)$	.00	16.89	.00	19.92	10.67	17.29

z-statistics are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

5. Tests for publication bias

Figure A3. Contour-enhanced funnel plot of studies

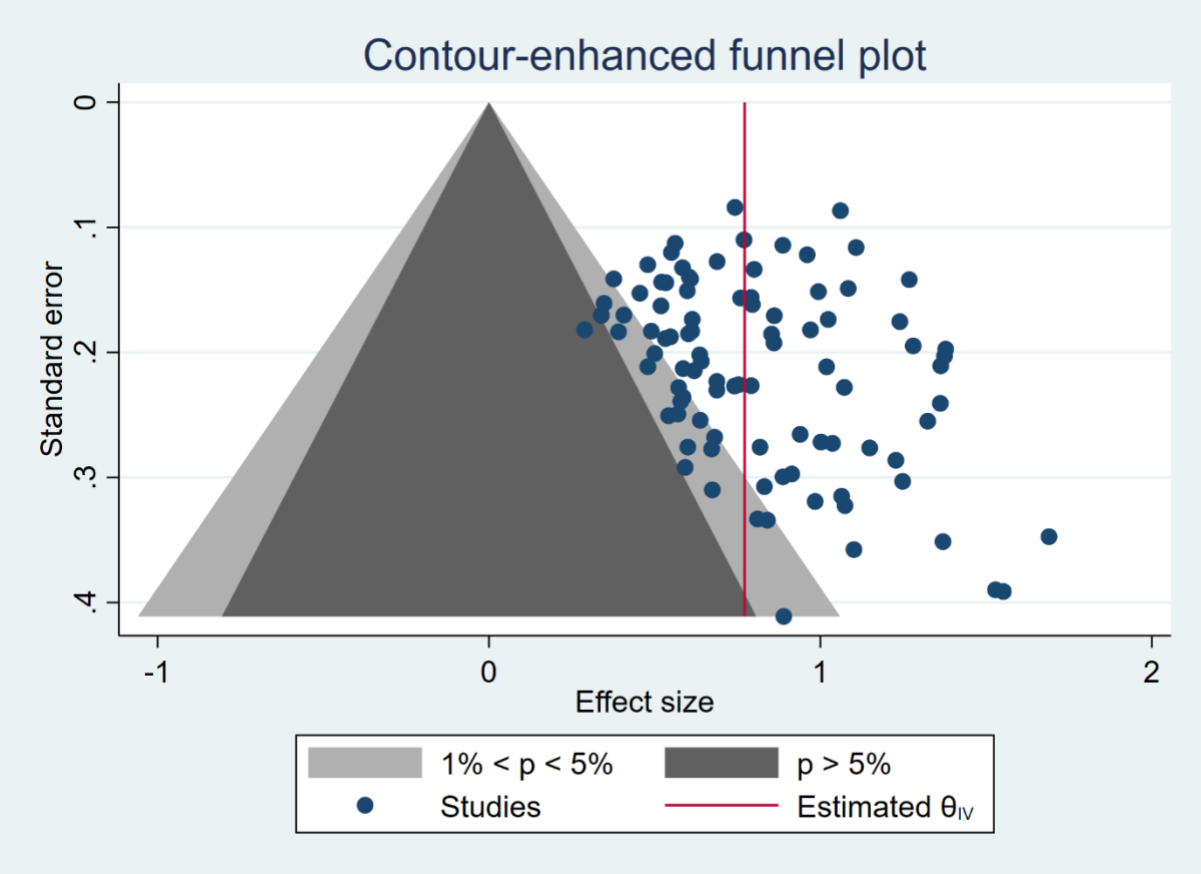


Table A4. Results from Egger test and Skewness test

	Egger coeff	*Egger p* – value	*Skewness coeff*	*Skewness p* – value	*Combined p* – value
All	1.34	.003	.578	.016	.008
Visual	1.03	.223	.193	.636	.340
Verbal	-.04	.962	.402	.266	.461
Combination	2.83	.000	.705	.033	.004

Table A5. Results from Egger test and Skewness test- with verbal manipulation subgroups

	Egger coeff	*Egger p* – value	*Skewness coeff*	*Skewness p* – value	*Combined p* – value
All	1.34	.003	.578	.016	.008
Visual	1.03	.223	.193	.636	.340
Verbal cues	.69	.558	.337	.417	.660
Verbal instructions	.16	.930	.863	.063	.122
Combination	2.83	.000	.705	.033	.004

Appendix B: Chapter 3

1. Literature search: keywords identification

Prior to identifying the key search terms, I conducted a literature review that only used the desired intervention ("anthropomorphism") and outcome variable ("consumer behaviour") of the focal effect for my meta-analysis. The exploratory review process showed my focal topic appeared in multidisciplinary studies, including consumer research, business, psychology and human-computer interactions. Therefore, I revised my search terms by including possible relevant terms and thesaurus terms.

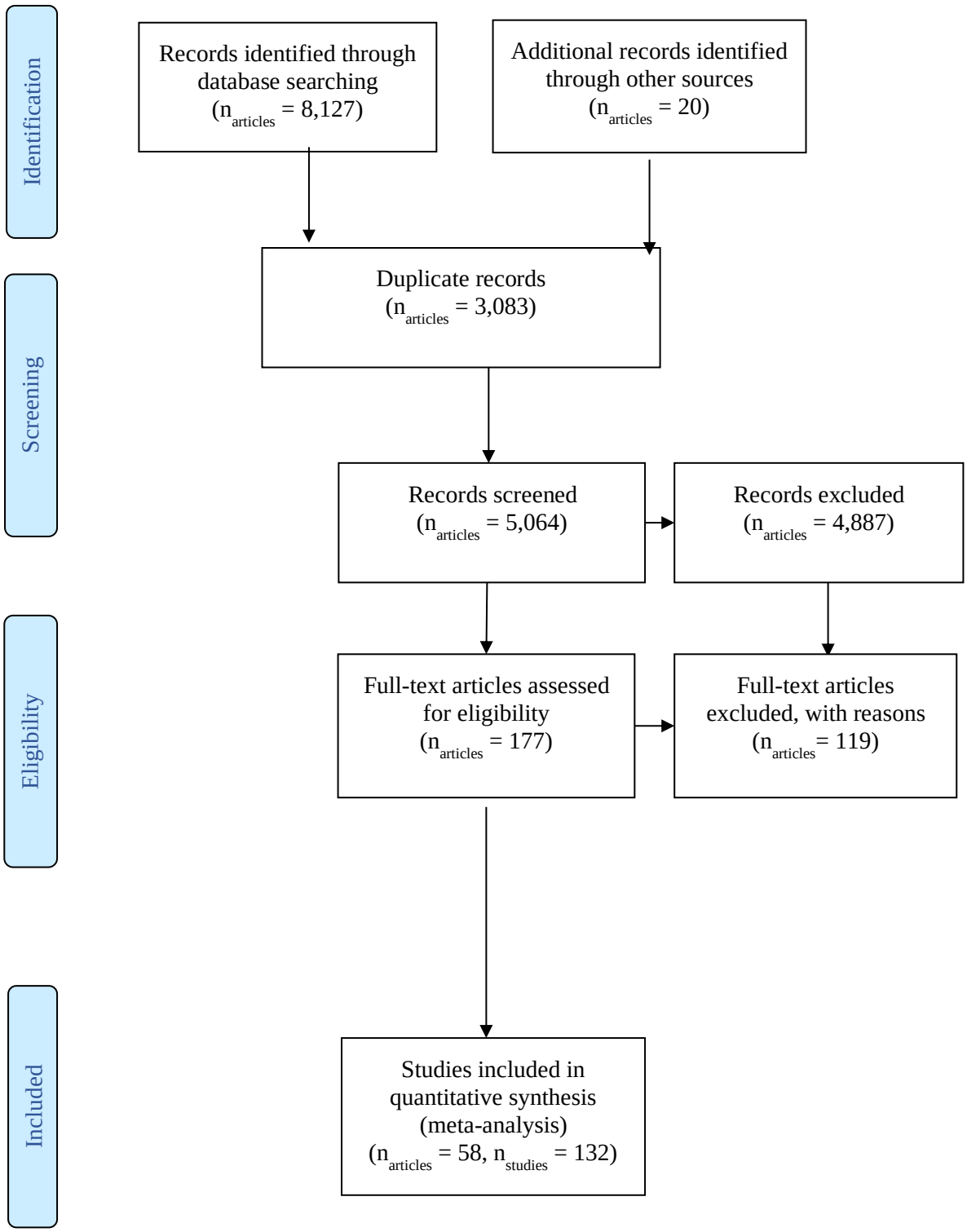
Table B1. Literature search terms

Anthropomorphism	**Consumer behaviour Or Inference process**
Anthropomorphism*	Consumer behavior*
"Anthropomorphic condition"	Buyer behavior*
Anthropomorphized*	Consumer reaction*
Anthropomorphizing*	Consumer response*
Humanizing*	Consumption
Humanized*	User satisfaction
Humanlike*	Engagement
Humanoid	User Interaction
	Mind perception
	Mind attribution
	Inference process

Note: To be indexed, studies will need to mention at least one term from each column (i.e., anthropomorphism* AND consumer behaviour*). *- for right-hand truncation; ""- for exact term

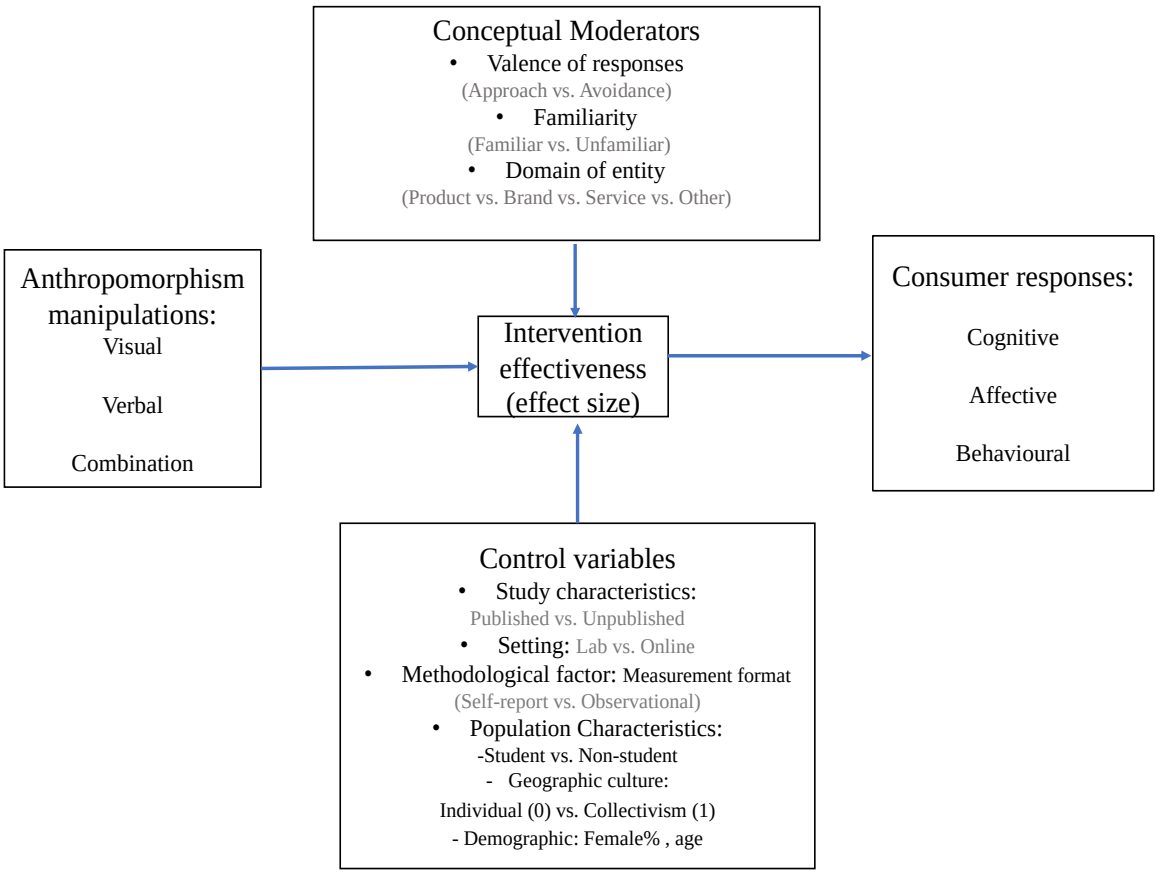
2. Data collection process illustration

Figure B1. Flow diagram for literature search procedures (adapted from PRISMA protocol)



3. Variable coding and conceptual framework

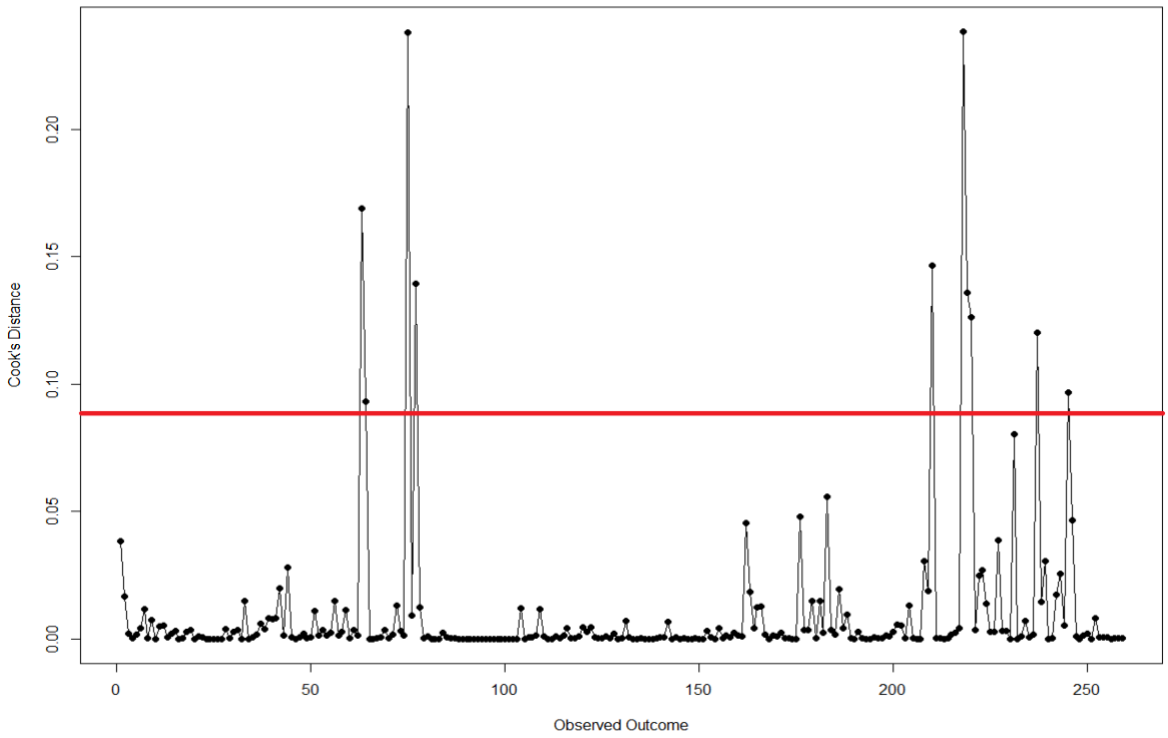
Figure B2. Conceptual framework: illustration on the related variables in meta-analysis



4. Data analysis

1) Outlier detection

Figure B3. Cook's distance plot



2) Model evaluation

Table B2. Comparing different Random effect structure (without outliers)

	AIC	*BIC*	Likelihood Ratio test
Full model	522.23	536.28	233.01 ($p < .001$)
Restricted model	751.24	758.27	

Note:
-Full model is the multi-level (paper, study, effect size) model
- Restricted model is the one-level (effect size) model

3) Moderator analysis

Table B3. Meta-regression results multi-level model: visual baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	.425***	.345**	.355**	.429***	.237**	.477***	.246
	(.097)	(.132)	(.133)	(.104)	(.095)	(.127)	(.172)
Manipulation type: Verbal		.301*					.322**
		(.146)					(.145)
Manipulation type sub: Verbal cues			.343*				
			(.173)				
Manipulation type sub: Verbal instructions			.170				
			(.288)				
Manipulation type: Combination		−.078	−.096				−.060
		(.144)	(.143)				(.163)
Valence of responses: Avoidance				−.040			−.040
				(.227)			(.228)
Domain of entity: Product					.171		.197
					(.129)		(.142)
Domain of entity: Service					−.314		−.331
					(.175)		(.164)
Domain of entity: Other					.366		.337
					(.228)		(.221)
Familiarity: Yes						−.156	−.282*
						(.137)	(.156)
N	249	249	249	249	249	249	249
τ^2 (total)	.720	.693	.681	.720	.700	.727	.679
L3 (Paper)	.326	.293	.264	.324	.297	.337	.278
L2 (Study)	.282	.288	.305	.282	.291	.277	.286
L1 (Effect size)	.112	.112	.112	.114	.112	.112	.114
I^2(%) (total)	96.60	96.43	96.33	96.59	96.46	96.61	96.29
L3 (Paper)	43.73	40.76	37.40	43.46	40.95	44.82	39.47
L2 (Study)	37.86	40.11	43.11	37.89	40.07	36.86	40.62
L1 (Effect size)	15.01	15.56	15.82	15.24	15.44	14.93	16.20

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Table B4. Meta-regression results multi-level model: verbal baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	.425***	.646***	.698***	.429***	.237**	.477***	.568***
	(.097)	(.155)	(.196)	(.104)	(.095)	(.127)	(.162)
Manipulation type: Visual		−.301*	−.343*				−.322**
		(.146)	(.173)				(.145)
Manipulation type sub: Verbal instructions			−.173				
			(.354)				
Manipulation type: Combination		−.379**	−.439**				−.381**
		(.147)	(.185)				(.156)
Valence of responses: Avoidance				−.040			−.040
				(.227)			(.228)
Domain of entity: Product					.171		.197
					(.129)		(.142)
Domain of entity: Service					−.314		−.331
					(.175)		(.164)
Domain of entity: Other					.366		.337
					(.228)		(.221)
Familiarity: Yes						−.156	−.282*
						(.137)	(.156)
N	249	249	249	249	249	249	249
τ^2 (total)	.720	.693	.681	.720	.700	.727	.679
L3 (Paper)	.326	.293	.264	.324	.297	.337	.278
L2 (Study)	.282	.288	.305	.282	.291	.277	.286
L1 (Effect size)	.112	.112	.112	.114	.112	.112	.114
I^2(%) (total)	96.60	96.43	96.33	96.59	96.46	96.61	96.29
L3 (Paper)	43.73	40.76	37.40	43.46	40.95	44.82	39.47
L2 (Study)	37.86	40.11	43.11	37.89	40.07	36.86	40.62
L1 (Effect size)	15.01	15.56	15.82	15.24	15.44	14.93	16.20

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Table B5. Meta-regression results multi-level model: combination baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	.425***	.267***	.259***	.429***	.237**	.477***	.187*
	(.097)	(.076)	(.076)	(.104)	(.095)	(.127)	(.088)
Manipulation type: Verbal		.379**					.381**
		(.147)					(.157)
Manipulation type sub: Verbal cues			.439**				
			(.185)				
Manipulation type sub: Verbal instructions			.266				
			(.280)				
Manipulation type: Visual		.078	.096				.060
		(.144)	(.143)				(.163)
Valence of responses: Avoidance				−.040			−.040
				(.227)			(.228)
Domain of entity: Product					.171		.197
					(.129)		(.142)
Domain of entity: Service					−.314		−.331
					(.175)		(.164)
Domain of entity: Other					.366		.337
					(.228)		(.221)
Familiarity: Yes						−.156	−.282*
						(.137)	(.156)
N	249	249	249	249	249	249	249
τ^2 (total)	.720	.693	.681	.720	.700	.727	.679
L3 (Paper)	.326	.293	.264	.324	.297	.337	.278
L2 (Study)	.282	.288	.305	.282	.291	.277	.286
L1 (Effect size)	.112	.112	.112	.114	.112	.112	.114
I^2(%) (total)	96.60	96.43	96.33	96.59	96.46	96.61	96.29
L3 (Paper)	43.73	40.76	37.40	43.46	40.95	44.82	39.47
L2 (Study)	37.86	40.11	43.11	37.89	40.07	36.86	40.62
L1 (Effect size)	15.01	15.56	15.82	15.24	15.44	14.93	16.20

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

4) Additional analysis with control variables

Table B6. Multi-level meta-regression results with control variables (N = 221)

	Coefficient	SE	t-stat	p-value
Intercept	.255	.266	.96	.355
Manipulation type: Verbal	.396	.156	2.54	.024
Manipulation type: Combination	-.080	.181	-.44	.663
Valence of responses: Avoidance	-.035	.231	-.15	.885
Domain of entity: Product	.210	.160	1.31	.213
Domain of entity: Service	-.193	.162	-1.19	.293
Domain of entity: Other	.375	.236	1.59	.125
Familiarity: Yes	-.235	.161	-1.46	.155
Measurement format: Self-report	.035	.241	.15	.889
Publication status: Unpublished	-.353	.178	-1.98	.092
Population characteristics: Non-student	.165	.535	.31	.780
Experimental setting: Online	-.325	.525	-.62	.590

5) Sensitivity analysis

Table B7. Results under different correlational assumptions
(multi-level model with type of manipulation only, visual baseline)

	baseline	$r = 0.2$	$r = 0.5$	$r = 0.8$
Intercept	.345**	.347**	.347***	.341***
	(.132)	(.124)	(.114)	(.105)
Verbal	.301*	.287*	.270*	.261*
	(.177)	(.142)	(.138)	(.135)
Combination	-.078	-.100	-.125	-.138
	(.193)	(.138)	(.131)	(.124)
τ^2	.693	.636	.566	.512
I^2	96.43%	96.48%	97.25%	98.67%

Table B8. Results under different correlational assumptions
(multi-level model with type of manipulation only, verbal baseline)

	baseline	$r = 0.2$	$r = 0.5$	$r = 0.8$
Intercept	.646***	.635***	.617***	.601***
	(.155)	(.149)	(.140)	(.132)
Visual	-.301*	-.287*	-.270*	-.261*
	(.146)	(.142)	(.138)	(.135)
Combination	-.379**	-.387**	-.395***	-.398***
	(.147)	(.145)	(.141)	(.138)
τ^2	.693	.636	.566	.512
I^2	96.43%	96.48%	97.25%	98.67%

6) Supplementary analysis

Multivariate analysis

Table B9. Meta-regression results multivariate multi-level model: visual baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept							
Affective	.454***	.471**	.485**	.484***	.202	.476***	.305
	(.127)	(.165)	(.166)	(.118)	(.115)	(.152)	(.222)
Behavioural	.269**	.157	.175	.344***	.421	.331***	.271
	(.106)	(.153)	(.155)	(.093)	(.203)	(.111)	(.287)
Cognitive	.548***	.386**	.401**	.485***	.305**	.599***	.177
	(.133)	(.183)	(.189)	(.143)	(.132)	(.168)	(.213)
Manipulation type: Verbal							
Affective		.262					.330
		(.308)					(.337)
Behavioural		.257					.226
		(.195)					(.174)
Cognitive		.486**					.483**
		(.181)					(.163)
Manipulation type: Combination							
Affective		−.231	−.261				−.161
		(.191)	(.190)				(.238)
Behavioural		.047	.015				.050
		(.194)	(.192)				(.177)
Cognitive		.007	−.019				.070
		(.207)	(.212)				(.225)
Valence of responses: Avoidance							
Affective				−.356			−.382
				(.133)			(.172)
Behavioural				−.563**			−.498*
				(.060)			(.149)
Cognitive				.237			.169
				(.251)			(.270)
Manipulation type sub: Verbal cues							
Affective			.206				
			(.361)				
Behavioural			.271				
			(.235)				
Cognitive			.598***				
			(.169)				
Manipulation type sub: Verbal instructions							
Affective			.409				
			(.298)				
Behavioural			.144				
			(.266)				
Cognitive			.180				
			(.386)				
Domain of entity: Product							
Affective					.211		.170
					(.162)		(.182)
Behavioural					−.102		.088
					(.244)		(.240)
Cognitive					.142		.224
					(.133)		(.141)
Domain of entity: Service							
Affective					−.213		−.121
					(.254)		(.238)
Behavioural					−.636*		−.523
					(.281)		(.298)
Cognitive					−.696**		−.612**
					(.218)		(.218)
Domain of entity: Other							
Affective					.658		.556
					(.533)		(.520)
Behavioural					−.102		−.028
					(.278)		(.287)
Cognitive					.585*		.591*
					(.299)		(.318)
Familiarity: Yes							
Affective						−.021	−.204
						(.252)	(.270)
Behavioural						−.177	−.093
						(.171)	(.138)
Cognitive						−.155	−.364*
						(.208)	(.204)
N	249	249	249	249	249	249	249
τ^2 (total)	.740	.721	.716	.707	.722	.753	.702
L3 (Paper)	.369	.344	.313	.341	.371	.380	.357
L2 (Study)	.268	.273	.306	.276	.246	.268	.251
L1 (Effect size)	.104	.103	.097	.091	.106	.105	.095
I^2(%) (total)	96.65	96.46	96.35	96.48	96.51	96.65	96.21
L3 (Paper)	48.11	46.10	42.09	46.46	49.53	48.78	48.85
L2 (Study)	34.97	36.60	41.20	37.63	32.87	34.36	34.35
L1 (Effect size)	13.57	13.76	13.06	12.39	14.10	13.51	13.02

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Table B10. Meta-regression results multivariate multi-level model: verbal baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept							
Affective	.454***	.733**	.691*	.484***	.202	.476***	.635*
	(.127)	(.286)	(.358)	(.118)	(.115)	(.152)	(.341)
Behavioural	.269**	.414**	.446*	.344***	.421	.331***	.497
	(.106)	(.162)	(.209)	(.093)	(.203)	(.111)	(.242)
Cognitive	.548***	.872***	.998***	.485***	.305**	.599***	.660***
	(.133)	(.212)	(.220)	(.143)	(.132)	(.168)	(.213)
Manipulation type: Visual							
Affective		−.262	−.206				−.330
		(.308)	(.361)				(.337)
Behavioural		−.257	−.271				−.226
		(.195)	(.235)				(.174)
Cognitive		−.486**	−.598***				−.483**
		(.181)	(.169)				(.163)
Manipulation type: Combination							
Affective		−.493	−.467				−.491
		(.285)	(.349)				(.357)
Behavioural		−.210	−.256				−.176
		(.151)	(.175)				(.175)
Cognitive		−.479**	−.617**				−.413*
		(.208)	(.229)				(.217)
Valence of responses: Avoidance							
Affective				−.356			−.382
				(.133)			(.172)
Behavioural				−.563**			−.498*
				(.060)			(.149)
Cognitive				.237			.169
				(.251)			(.270)
Manipulation type sub: Verbal instructions							
Affective			.203				
			(.423)				
Behavioural			−.127				
			(.360)				
Cognitive			−.418				
			(.410)				
Domain of entity: Product							
Affective					.211		.170
					(.162)		(.182)
Behavioural					−.102		.088
					(.244)		(.240)
Cognitive					.142		.224
					(.133)		(.141)
Domain of entity: Service							
Affective					−.213		−.121
					(.254)		(.238)
Behavioural					−.636*		−.523
					(.281)		(.298)
Cognitive					−.696**		−.612**
					(.218)		(.218)
Domain of entity: Other							
Affective					.658		.556
					(.533)		(.520)
Behavioural					−.102		−.028
					(.278)		(.287)
Cognitive					.585*		.591*
					(.299)		(.318)
Familiarity: Yes							
Affective						−.021	−.204
						(.252)	(.270)
Behavioural						−.177	−.093
						(.171)	(.138)
Cognitive						−.155	−.364*
						(.208)	(.204)
N	249	249	249	249	249	249	249
τ^2 (total)	.740	.721	.716	.707	.722	.753	.702
L3 (Paper)	.369	.344	.313	.341	.371	.380	.357
L2 (Study)	.268	.273	.306	.276	.246	.268	.251
L1 (Effect size)	.104	.103	.097	.091	.106	.105	.095
I^2(%) (total)	96.65	96.46	96.35	96.48	96.51	96.65	96.21
L3 (Paper)	48.11	46.10	42.09	46.46	49.53	48.78	48.85
L2 (Study)	34.97	36.60	41.20	37.63	32.87	34.36	34.35
L1 (Effect size)	13.57	13.76	13.06	12.39	14.10	13.51	13.02

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

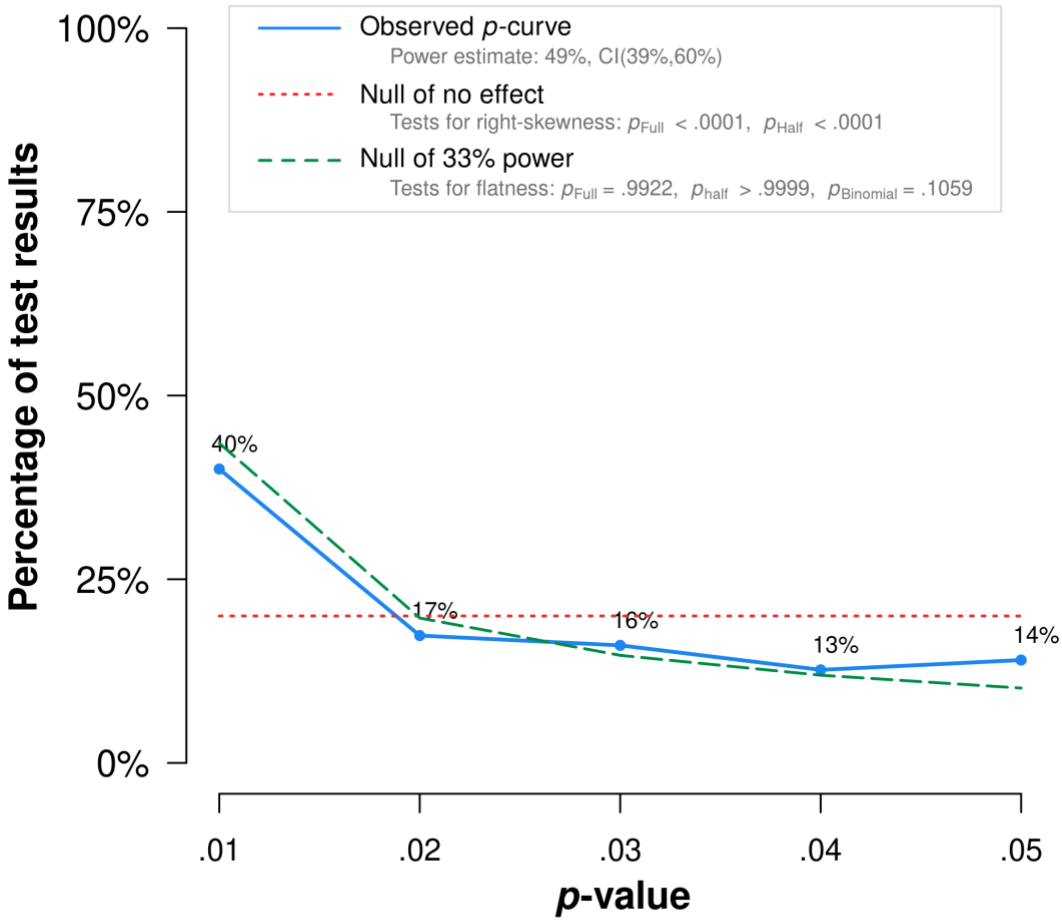
Table B11. Meta-regression results multivariate multi-level model: combination baseline

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept							
Affective	.454***	.240*	.224*	.484***	.202	.476***	.144
	(.127)	(.114)	(.113)	(.118)	(.115)	(.152)	(.123)
Behavioral	.269**	.204*	.190	.344***	.421	.331***	.321
	(.106)	(.112)	(.112)	(.093)	(.203)	(.111)	(.247)
Cognitive	.548***	.393***	.382***	.485***	.305**	.599***	.247
	(.133)	(.129)	(.128)	(.143)	(.132)	(.168)	(.148)
Manipulation type: Verbal							
Affective		.493					.491
		(.285)					(.357)
Behavioural		.210					.176
		(.151)					(.175)
Cognitive		.479**					.413*
		(.208)					(.217)
Manipulation type: Visual							
Affective		.231	.261				.161
		(.191)	(.190)				(.238)
Behavioural		−.047	−.015				−.050
		(.194)	(.192)				(.177)
Cognitive		−.007	.019				−.070
		(.207)	(.212)				(.225)
Valence of responses: Avoidance							
Affective				−.356			−.382
				(.133)			(.172)
Behavioural				−.563**			−.498*
				(.060)			(.149)
Cognitive				.237			.169
				(.251)			(.270)
Manipulation type sub: Verbal cues							
Affective			.467				
			(.349)				
Behavioural			.256				
			(.175)				
Cognitive			.617**				
			(.229)				
Manipulation type sub: Verbal instructions							
Affective			.670*				
			(.278)				
Behavioural			.129				
			(.288)				
Cognitive			.199				
			(.362)				
Domain of entity: Product							
Affective					.211		.170
					(.162)		(.182)
Behavioural					−.102		.088
					(.244)		(.240)
Cognitive					.142		.224
					(.133)		(.141)
Domain of entity: Service							
Affective					−.213		−.121
					(.254)		(.238)
Behavioural					−.636*		−.523
					(.281)		(.298)
Cognitive					−.696**		−.612**
					(.218)		(.218)
Domain of entity: Other							
Affective					.658		.556
					(.533)		(.520)
Behavioural					−.102		−.028
					(.278)		(.287)
Cognitive					.585*		.591*
					(.299)		(.318)
Familiarity: Yes							
Affective						−.021	−.204
						(.252)	(.270)
Behavioural						−.177	−.093
						(.171)	(.138)
Cognitive						−.155	−.364*
						(.208)	(.204)
N	249	249	249	249	249	249	249
τ^2 (total)	.740	.721	.716	.707	.722	.753	.702
L3 (Paper)	.369	.344	.313	.341	.371	.380	.357
L2 (Study)	.268	.273	.306	.276	.246	.268	.251
L1 (Effect size)	.104	.103	.097	.091	.106	.105	.095
I^2(%) (total)	96.65	96.46	96.35	96.48	96.51	96.65	96.21
L3 (Paper)	48.11	46.10	42.09	46.46	49.53	48.78	48.85
L2 (Study)	34.97	36.60	41.20	37.63	32.87	34.36	34.35
L1 (Effect size)	13.57	13.76	13.06	12.39	14.10	13.51	13.02

Standard errors are presented in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

5. Publication bias

Figure B4. p-curve analysis



Note: The observed *p*-curve includes 150 statistically significant ($p < .05$) results, of which 99 are $p < .025$. There were 59 additional results entered but excluded from *p*-curve because they were $p > .05$.

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