The Rumsfeld Effect: The unknown unknown.

James A. Hampton,

Bayo Aina,

J. Mathias Andersson,

Humaira Z. Mirza,

and

Sejal Parmar

City University, London

Address for correspondence:
James A. Hampton
Psychology Department
City University
Northampton Square
London EC1V OHB

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Abstract

A set of studies tested whether people can use awareness of ignorance to provide enhanced test consistency over time if they are allowed to place uncertain items into a "don't know" category. For factual knowledge this did occur, but for a range of other forms of knowledge relating to conceptual knowledge and personal identity, no such effect was seen. Known unknowns would appear to be largely restricted to factual kinds of knowledge.

Many statements in natural language may be termed vague. A vague statement is one that is neither clearly true nor clearly false. Philosophical treatments of vagueness (Keefe & Smith, 1997; Williamson, 1994) have largely focused on the logical problems surrounding the Sorites Paradox. Named for the Greek word for "heap" the paradox concerns whether removing just one grain of sand from a heap could ever make the difference to the truth of the statement "this is a heap". Of course, if the answer is no, then the heap can be reduced one grain at a time until all the sand has gone, while in the style of the smile on the face of Carroll's Cheshire Cat the heap remains. But the answer yes just seems counter-intuitive, especially considering that the grain size can be reduced at will making each step infinitesimally small. Vagueness more broadly has also been demonstrated in other domains, such as geographical location (Fisher et al. 2004).

Our interest in vagueness in the present paper first arose in the context of categorization. In a seminal paper by McCloskey and Glucksberg (1978), they provided evidence that people's understanding of most of our common semantic categories, such as Sports, Fruit or Vehicles is vague. McCloskey and Glucksberg gave participants lists of possible category members (e.g. for fruit it could include apple, pineapple, coconut, olive, pumpkin), and asked them to say Yes or No as to whether they were members of the category. The participants returned some weeks later and repeated the task. Vagueness in categorization was seen in two ways. First there were in each list borderline items for which there was poor consensus. In fact the likelihood of people saying Yes was smoothly distributed across the scale from zero to one (see Hampton, 1998). Second, where people disagreed about categorization they were also more likely to be inconsistent in their responses across the two occasions. In other words, items such as olive as a fruit were not at the borderline just because of different beliefs across individuals, but they were also borderline because many individuals did not hold a

consistent belief of their own about the categorization.

The principal question that is posed here concerns whether people are reliably aware of this uncertainty and potential inconsistency in their judgments of the truth of statements. The experiments to be reported examined a number of different knowledge domains, but we illustrate the issue first in respect of categorization.

A strong case can be made that there are certain statements which everyone would agree are true or false, while there are other statements that everyone would acknowledge are borderline or difficult to agree on. The latter we might term the "known unknown" to use a phrase made familiar by Donald Rumsfeld, Secretary of Defence of the USA from 2001 to 2006, under President George W. Bush (Seely, 2003). For example everyone would agree that apples, oranges and bananas are fruit, and that potatoes and cabbages are clearly not. Then again, perhaps everyone would agree that it is difficult to classify tomatoes, olives, avocados and pumpkins as fruit. If this *triage* is possible, then it should be the case that allowing people three response options in a categorization task (Clearly True, Unclear, and Clearly False) should improve the consistency of the responses at retest. A person who knows that the truth of a statement is unclear can simply use the middle response on each occasion. On the other hand if they are forced to choose between True and False, as in the traditional categorization task, they will have to make a decision as best they can, and may therefore have a higher likelihood of giving an inconsistent response at retest.

The comparison of consistency in responding between a 3-response (Clearly True, Unclear, and Clearly False) and a 2-response (True, False) group thus provides a novel test of metacognitive awareness of the vagueness or uncertainty in a decision. Before briefly describing other work on similar problems of metacognition, let us consider an alternative hypothesis about how people may respond when given 3 rather than 2 responses to use. According to the threshold model of categorization (Hampton, 2007;

Verheyen, Hampton & Storms, 2010), people decide whether an item is in a category by comparing it with a prototype representation of the category concept. Integrating across different dimensions whose relevance and weight is determined by the concept and by the context, an overall similarity is calculated and compared to a threshold criterion. If the similarity surpasses the criterion a True response is triggered, and if not, a False is given. Random variation in the process of computing similarities and variation in the placement of the criterion naturally lead to the kind of probabilistic responding and inconsistency seen in the McCloskey and Glucksberg data. They also explain the slower decision times seen near to the category borderline (Hampton, 1979, 1995; McCloskey & Glucksberg, 1979). To adapt the model to the 3-response version of the task, one can simply propose that the participant adopts two threshold criteria, one higher threshold to separate a Clearly True from an Unclear, and a second lower threshold to differentiate an Unclear from a Clearly False. The Unclear response will therefore be most likely to be given to items with intermediate levels of similarity to the category, falling between the two threshold points. Note however that the variability in the computation of similarity and the placement of criteria is not affected by this adaptation. So whatever sources of variance led to probabilistic responses and inconsistency in the 2-response case will still be present with equal force in the 3-response case. So the threshold model predicts that providing 3 responses will have no effect on the level of inconsistency observed in categorization. It will be just as hard to remain consistent when deciding what is *clearly* a fruit as it is when deciding what is a fruit *simpliciter*.

Metacognitive awareness. The question of how aware people are of their degree of knowledge has attracted a large amount of research in the field of metacognition. It is known for example, that people are generally overconfident in estimating the number of answers that they get correct on a quiz (Fischoff et al. 1977). In fact when they state they are 100% certain of the answer, on average they may be wrong around 10% of the

time. A large literature on calibration of judgments exists which relates people's subjective estimates of the probability of being correct to their actual accuracy (Lichtenstein et al., 1982, Koehler et al., 2002). Another literature has grown up around the concept of Feeling of Knowing (Klin, Guzman & Levine, 1997; Koriat, 1993). It has been demonstrated that when recall of an item fails in a cued recall task, people can reliably predict which targets they would be able to recognize in a subsequent recognition test. This research has been extended to negative feelings of knowing—knowing that you will not be able to remember something—in work by Liu, Su, Xu & Chan (2007).

The possibility of awareness of ignorance (known unknowns) was demonstrated in an early study by Glucksberg and McCloskey (1981). They showed that providing people with relevant but uninformative facts slowed down a "don't know" response. They argued that there are two ways in which we may decide that we don't know the answer to a question. One is that we find no relevant information in memory as in their example of "Does Margaret Thatcher use an electric tooth-brush?" In this case a rapid and definite "don't know" could be given in 1981. The other way to arrive at a "don't know" is when there is relevant information available, but it is insufficient to lead to a confident judgment – as for example in asking whether Kiev is in the Ukraine. This type of "don't know" will be slow and deliberative, as people attempt to use the relevant evidence within their existing knowledge base to arrive at an answer, and then decide that they cannot decide.

Glucksberg and McCloskey proposed a two-stage model for verification of a fact. First there is a search for relevant information, and then if such information is found, there is an evaluative stage. A "don't know" response can result from either stage. As regards the analysis of category vagueness described above, the model would suggest that only in the case of a lack of any relevant knowledge of the item in question will an

"Unclear" response result from the first quick stage.

The research described thus far is largely concerned with the relation of confidence to *accuracy.* Apart for some indirectly related studies in opinion survey methodology (e.g. Gilljam & Granberg, 1993) there has been little research on the general consistency of question answering, regardless of whether the answer is correct or not. The issue is of particular importance for the epistemological foundations of our knowledge. If we are sure of a fact, then it is tempting to consider that knowledge to be permanently represented in long term memory in a way that ensures that a stable response is produced whenever the fact is questioned. Intuitively there is a strong connection between feeling 100% confident in the truth (or falsity) of a statement and being consistent in that belief over time, in the absence of any new information (regardless of whether one is correct in one's belief).

Overview of the research. The question that we address here concerns the consistency with which people answer True/False statements. We consider not just categorization statements but also general knowledge and other kinds of statement. The procedure adopted for Experiments 1 – 3 is to compare consistency for a group who simply answer Yes or No, with that for a group who are allowed 3 responses, Definitely True, Uncertain and Definitely False. (Experiment 4 adopted a within-subjects version of the procedure). The question is whether the latter group show increased consistency relative to the former. Our research differs in two important respects from previous research in this area. First, we do not restrict ourselves to statements for which there is an objectively determined truth or falsity. Hence we are not primarily concerned with calibration and accuracy. Second, in addition to objective facts we also consider a range of other types of knowledge, such as the membership of conceptual categories, personal moral beliefs and values, and personal aspirations and preferences, which cannot be verified by appeal to an external reality. We are particularly interested, not in whether

confidence is well calibrated across the scale, but in whether a sense of being 100% *certain* about a statement is a stable state that perseveres across time, and equivalently whether being *uncertain* about the truth of a statement is also a stable state of belief.

In setting the scene for the research to be reported, it is important to distinguish two questions that the research addresses. Our primary concern, as stated above is to test whether being 100% certain of a belief provides additional consistency over time. The methodology of comparing consistency between the 2-response and 3-response groups addresses this question. A second question is whether this effect differs in a qualitative way across different domains of knowledge. As will be seen, there is evidence that the consistency advantage shown for the 3-response group is only seen in general knowledge domains. Given the difficulty in finding an appropriate and representative sampling procedure for selecting statements from different domains, it may be harder to prove that this interaction reflects a qualitative rather than a quantitative difference among domains. We return to this issue in the final discussion.

Predictions. On the basis of the foregoing arguments it is possible to predict either of two outcomes to the procedure of comparing consistency between a 2-response and a 3-response group. First, it can be argued that if a person is asked to say True or False of a statement only if they are 100% certain of the answer, and otherwise to say “unsure”, then this sense of certainty should guarantee that they give the same response on both occasions. After all, how could one be definitely sure that something is the case, but then be uncertain, or even sure that it is false just two weeks later? (Assuming the facts have not changed and nothing has happened to lead a person to change their view in the mean time.) If long term memory contains a set of stable known facts, and if people can differentiate these from those about which they are not completely certain, then the 3-response condition should show better consistency. Equivalently, if a person can find no relevant information in memory that could be used to evaluate a statement, then that fact

alone should lead them to an Unsure response on both occasions, and so improve consistency.

Alternatively an analogy can be drawn with a familiar kind of decision making, that of a juror who must decide on a verdict. In a criminal case (in England and Wales), the jury is instructed to bring in a guilty verdict only if the evidence proves guilt "beyond a reasonable doubt". In a civil law case, a jury has to decide between the two parties on the balance of the argument. The former is akin to our 3-response category condition. Jurors could be convinced of guilt, convinced of innocence or in a state of doubt, and the law directs them to return "not guilty" in either of the latter two cases. (In Scottish law, the middle response of "Unproven" is also allowed). The civil law case is like our 2-response condition – either the plaintive has made their case or they have not. Experience with jury decision making suggests that the decision is no easier to make in the former case than the latter. Juries will find it just as hard to reach consensus on whether a case is proven beyond reasonable doubt, as on whether the evidence favors one side or the other on balance. In other words, this analogy implies that requiring people to only say True when they are definitely sure simply moves the decision criterion to a higher level, but does nothing about the problem of evaluating the truth of the statement itself, and the degree of instability and uncertainty that may be involved in assessing the likelihood of its truth.

For our initial exploration of this issue we created statements of three types, representing three different kinds of knowledge in long term memory. First we took statements representing semantic knowledge – membership in different semantic categories like Fruit, Sport or Tool. As discussed above, the threshold model (Hampton, 2007) predicts that the 3-response condition should show no more consistency than the 2-response condition. Second we took statements representing objective factual knowledge. Following Glucksberg and McCloskey (1981) we might expect there to be

known unknowns in the case of more abstruse general knowledge statements, thus leading to greater consistency in the 3-response group. Finally we generated a set of items concerning people's autobiographical details and memories. Here the prediction was harder to make. Although it can be argued that autobiographies correspond to objective historical facts, there is nonetheless an important difference from other non-personal statements. That difference is that if a statement is about one's self, it is more than likely that one will attempt to retrieve relevant information and use that in an evaluative decision process. In such a case, then autobiographical statements should resemble categorization statements more than they do facts of general knowledge. (Note that we should expect much less consensus in the case of personal statements, but the issue of consistency is unaffected by the level of consensus).

Experiment 1

Method

Participants. Thirty-two students (25 female) at City University London participated for course credit. There were 16 in each condition.

Materials. Booklets were constructed with 150 statements in a random order, comprising 50 general knowledge statements, 50 category membership statements and 50 autobiographical memory statements. The items are listed in Appendix A. We aimed broadly for each set of 50 statements to include approximately 15 that were clearly true, 15 that were clearly false, and 20 that might be uncertain. Items in the Appendix are labelled Y for Yes if at least 90% of participants in the 2-response condition said True (averaged across the two tests), and N for No if at least the same number said False.

Design and Procedure. Two versions of the booklets were constructed. One had the 2 response options "True" and "False", and the other had the 3 response options "100% sure it's true", "Not 100% sure either way", and "100% sure it's false". These will be referred to as 100% true, Unsure, and 100% false in the presentation of results.

Since it was important that participants would only use the true and false responses when they were certain about an answer, the instructions were as follows: “Please only choose option 1 if you are 100% sure that the statement is true, and only choose option 3 if you are 100% sure that the statement is false. In all other cases, please use the middle option. Don’t worry about using the middle option too much – we only want you to say True or False if you are completely clear in your mind about the statement.” Two random orders of statements were used, one for the first test and one for the retest which took place one week later. On the final page of the booklet at retest, two additional questions were added after the main set of statements: “Did you look up or discuss the answers to any of the questions since last week?” and “Did you try to remember your answers from last week in order to give the same answer?” These questions were included in order to provide a check on how participants had responded to the retest. While they had been unaware that the same questions would be asked again, it was nevertheless possible that they had made an effort to be consistent by recalling their earlier responses.[1]

Results

Consistency. There were just 10 missing responses from 32x150 = 4800 data points. Table 1 shows the cross-tabulation of responses given on test and retest for each of the types of material and for each condition. Cell frequencies are expressed as percentages, such that the sum of all 4, or of all 9, cells is 100%. (N for each table was between 797 and 800). Thus for example, 24.3% of responses to General knowledge questions were “100% sure it’s TRUE” on the first test, of which 19.3% were given the same answer at retest, corresponding to a consistency of 79% (19.3 out of 24.3).

Measures of consistency for each condition were calculated for the three different types of statement separately. For the 2-response condition, consistency was calculated as the proportion of True-True and False-False response pairs across test/retest. That is

the proportion of all first responses that were unchanged at retest. This value was 82% for category statements, 82% for general knowledge statements, and 88% for autobiographical statements.

Compared to the 2-response condition, consistency for the 3-response condition was *lower* if calculated simply as the proportion of first responses that were unchanged. However expected levels of consistency should be lower for 3 rather than 2 response choices, since of 9 possibilities only 3 are consistent, compared with 2 out of 4 for the 2-response case. For a fair comparison, separate measures of consistency were calculated for the likelihood of a 100% true remaining consistent and for the likelihood of a 100% false remaining consistent. For the first, the frequencies of Unsure and 100% false responses were collapsed, to yield a 2 x 2 table, from which the consistency of 100% true responses was calculated as for the 2-response condition. Similarly, for the second measure, 100% true and Unsure were collapsed to yield a 2x2 table for the calculation of the consistency of 100% false responses. Mean consistency calculated in this way is shown in Figure 1.

It can be seen in the Figure that there was no difference in consistency for 2- and 3-response groups for the category statements (M = .82 and .81 respectively). In contrast, general knowledge statements showed an increased level of consistency when Unsure responses were allowed (M = .82 for 2 responses and .90 for 3 responses). In the case of autobiographical facts, where we had made no strong prediction, there was no difference in consistency between 2-response and 3-response conditions (M = .88 and .86 respectively). Analysis of variance was run across participants and across items with factors of type of statement (3 levels) and response condition (2 vs 3 response options). There was a marginally significant main effect of type of statement (Min F'(2, 182) = 2.86, p = .06) and a significant interaction of type of statement with response condition (Min F'(2,142) = 3.83, p = .024). There was no overall effect of response condition

(F<1). Break-down analysis of the interaction confirmed that there was a significant effect of response condition only in the case of general knowledge (Min F'(1,56) = 3.98, p =.05).

In terms of the two final questions, only 2 participants reported having discussed or looked up answers, and their consistency was not notably different from the others in their group. In addition 13 participants said that they had tried to recall their earlier answers – 6 in the 2-response condition and 7 in the 3-response condition. A post hoc analysis was therefore possible, breaking down each group into those who did and those who did not try to recall their earlier responses. A 3-way ANOVA was run with the two factors of response condition and type of statement as before, plus a third factor of whether the participant reported trying to recall or not. Neither the main effect of trying to recall, nor any interactions involving recall were significant, whereas the interaction of response condition and statement type remained strong ($F(2, 56) = 7.08$, $p = .002$).

Discussion

Three types of knowledge were tested. For general knowledge statements, as predicted, there was a notable increase in consistency – from 82% consistency for the "True/False" condition to 90% consistency for the 3-response condition. Examination of the frequencies in Table 1 showed that a major reason for this consistency was the much greater frequency and consistency of "Not 100% sure either way" responses in this type of statement. Whereas for category and autobiographical statements a first response of not sure was only about 50% likely to be repeated at retest, for the general knowledge statements the figure rose to 80%. In other words being unsure was a common and a stable cognitive state for the general knowledge statements we used here. A consequence of having a large stable group of "Not sure" responses was that the likelihood of the definite yes and no responses was reduced, and hence their stability was also increased.[2]

In contrast, there was no evidence that people were more consistent in categorization if allowed to differentiate cases about which they were definitely sure from others where they were unsure. Power calculations for the category condition estimated an 80% chance of detecting a difference between the two conditions of 3% or greater.

The third kind of statement used was autobiographical. Here, interestingly, the pattern of results matched those of category statements. The general level of consistency was somewhat higher, which probably reflected the arbitrary sampling of statements of each type. We aimed to match response frequencies across the three types of material, and we did this fairly well for the 2 response condition (see top part of Table 1). However when allowed three responses, the autobiographical statements proved to have fewer Unsure and more 100% false than the category statements. It is perhaps possible that there are fewer statements about one's own life about whose truth one is not sure, but no attempt was made to sample statements in any systematic way.

The results of Experiment 1 lead us to infer that there may be a qualitative difference between the kind of knowledge retrieval involved in judging general facts and that involved in category membership or autobiographical memory decisions. This conclusion must be qualified with the acknowledgement that although a fairly large sample of each type of statement was used, there was no obvious way in which to sample them in a representative fashion. It is for this reason that all the statements are listed in the Appendix. The alternative to a qualitative difference in domains would be a quantitative difference across domains in the types of items and distribution of responses. For example, as shown in Appendix A, all three domains had equivalent numbers of Definitely True items (between 5 and 7), but General Knowledge had more Definitely False items (11) than did Category Knowledge (6 items). On the other hand, Autobiographical items also had more Definitely False (12) items but patterned like

Category Knowledge. More generally, the opportunity for the 3-response advantage to appear depends on there being a good sample of unclear items. In this respect, Category Knowledge had a greater opportunity (40 items with no 90% consensus of being true or false) than the other two domains, and yet still showed no advantage for the 3-response condition.

In the following experiment, we ran a larger scale replication of the categorization condition. Since the dissociation depends quite critically on the absence of an effect in categorization, we aimed to use a more powerful design to confirm that there is indeed no improvement in consistency with 3 responses when category membership is being judged. We returned to the issue of personally related information and sought to replicate the effect for General Knowledge in Experiments 3 and 4.

Experiment 2

Method

Participants. Seventy-one students (53 female) at a London college participated voluntarily. Sixty-two returned for the second test, and data for the other 9 were not used. In the final data there were 32 in the 2-response group and 30 in the 3-response group.

Materials. Six semantic categories were used, with a list of 22 items for each category. Items were taken from a set of category materials developed by Hampton, Dubois & Yeh (2006), and are listed in Appendix B. Hampton et al. aimed to sample from the full range of category membership from clear members to clear non-members. Based on earlier data, about half the items were expected to lie in the borderline region for categorization (probability of a “yes” response between .25 and .75). As in Appendix A, (Y) indicates items with a consensus of >90% for a yes response in the 2-response condition, and (N) the equivalent for a no response. Some 18% of items were in the first group, and 14% in the second group, leaving 68% with the intermediate category

membership required to be sensitive to the manipulation used.

Design and Procedure. Participants were allocated at random to either the 2- or the 3-response group. The 2-response group worked through the booklet choosing either "yes" or "no" to each category item. The 3-response group had the same booklet, but instead of "yes" or "no" they chose one of three responses: "definitely yes", "maybe" and "definitely no". Instructions for this group emphasized that a yes or no should only be given if the participant was confident that it was definitely the right answer. If a participant was unfamiliar with any item they were told to leave it blank. All participants were retested after a period of two weeks. The order of items was alphabetical within category for one half of the booklets in each condition and reverse alphabetical for the other. Order of categories was constant. Order was kept the same for each participant at test and retest. Participants wrote their names on coversheets each week so that booklets could be matched up. Cover sheets were then detached to preserve anonymity.

Results

Less than 2% of the data were missing owing to non-response to items. Item and subject statistics were calculated based on the valid data only. Table 2 shows percentages for the cross-tabulation of the responses given on the first and second occasions, rounded to the nearest integer. For example for the 2-response group, 52% of all responses at the first test were "yes", and these broke down into 45% where the second response was also "yes" and 7% where the second response was "no". Thus 86% (= 44.7/52.1) of initial yes responses were unchanged. Combining the consistent yes (44.7%) and consistent no (38.5%) percentages gave a total consistency of 83.2% for the 2-response group.

As in Experiment 1, participants were more likely to change their responses in the 3-response (74% consistent) than in the 2-response group (83% consistent). However, as

explained in Experiment 1, it is harder to be consistent in the allocation of 3 response categories than just 2. To compare like with like, the data from the 3-response group were analysed as in Experiment 1 to provide two separate estimates of consistency, one for Definitely Yes versus other responses, and one for Definitely No versus other responses. The two estimates were averaged together for an overall consistency measure for the 3-response group.

When calculated in this way, the mean consistency for the 3-response group was 83.6%, compared with 83.2% for the 2-response group. Standard errors for the two estimated means based on subject variance were 0.9% and 0.7%, giving 95% confidence intervals of ± 2% and ± 1.5% respectively. Estimated power was 95% for detecting a difference in the group population means of 2% or more, and 80% for a difference of 1% or more.

Consistency and response probability. A further analysis considered whether a shift in consistency may have been masked by changes in the distribution of items across the membership scale. Clearly if a given item has a 90% chance of a "yes" response in the 2-response group then it is more likely to receive the same response at retest than if it has a 50% chance of a "definitely yes" response in the 3-response group. The closer an item is to the criterion cut-off, the more inconsistent a response can be expected to be. In fact, assuming independence of the two responses, the expected consistency of a response in a two-choice repeated response task is $p^2 + q^2$ where p and q are the probabilities of the two responses ($p + q = 1$). This function reaches a minimum of 0.5 when $p = q = .5$, and rises to a maximum of 1 as p or q approaches 1. Adopting a high and low criterion could therefore generate shifts in consistency just by changing the number of items in the sample that are close to the criterion. Thus if response probability is treated as a covariate, it is possible that a difference in consistency could emerge between the two groups.

To examine this possibility, a data set was prepared based on the three different 2x2 tables that were used for the consistency calculations above. For each of the 132 items response probability and consistency were calculated for: (1) the 2x2 cross-tabulation table for the 2-response group, (2) the 2x2 table for the 3-response group, collapsing Unsure and Definitely No and (3) the 2x2 table for the 3-response group, collapsing Definitely Yes and Unsure. Consistency was entered into the dataset for each item, together with the response probability of the modal response (i.e. probability of a yes where yes was the more common response, and probability of a no if no were more frequently given). To illustrate, the item Chess as a Sport contributed three pairs of values to the dataset. In the 2-response group it had a probability of a "No" (the modal response) of .58 and a consistency of .83; with the high criterion applied to the 3-response group data the modal response was [Definitely No or Unsure] which occurred with a probability of .77 and had a consistency of .87; and with the low criterion applied to the 3-response group data the modal response of [Definitely Yes or Unsure] had a probability of .60 and a consistency of .77.

As expected, modal response probability MRP correlated significantly with consistency ($r(396) = .773$, $p < .001$). Higher MRP necessarily yields higher consistency. The question is then whether this may have been masking a difference in consistency between the 2- and 3-response groups. Accordingly an ANCOVAR was run on consistency with Response group as between-items factor, and MRP as a covariate. The results showed a very significant effect of MRP ($F(1,393) = 583.3$, $p < .001$) but still no effect at all of Response group ($F = 0.1$). The lack of any difference between groups was not therefore an artefact of shifts in response probability between groups.

Discussion

Experiment 2 confirmed the results of Experiment 1. There was no improvement in consistency when people were given the opportunity of only categorizing items about

which they were sure, and leaving the rest unclassified. With 132 items and 62 participants, the power of the experiment was sufficient to detect even a small improvement in the consistency of judgment in the 3- versus the 2-response condition. There was no evidence at all that allowing participants the option of saying “maybe” rather than forcing them to choose between “yes” and “no” helped to reduce the inconsistency of their categorization responses over time. The power was also sufficient to test whether an effect was being masked by a shift in item modal response probability between conditions (consistency being constrained as MRP approaches ceiling). There was no evidence for this possibility.

The results supported the proposal (Hampton, 2007) that category membership falls on a continuum. Decisions are subject to variation because of a range of factors that lead to items being placed higher or lower on the continuum on different occasions. As a consequence consistency is no greater if a higher standard of certainty is required than if people just give a yes or no answer. They also support the conclusion that by and large there are no known unknowns when it comes to categorizing familiar items in their superordinate categories.

The third experiment aimed to extend the study to a further domain. Following the results for autobiographical facts in Experiment 1, we adopted the working hypothesis that the advantage for consistency of being able to say “unsure” is restricted to matters of external objective fact, and that where questions of opinion or internal memory are involved there is no stable category of known unknowns. To test this notion, Experiment 3 again compared three domains of knowledge: general knowledge, personal ethical beliefs and personal aspirations. We expected to replicate the greater consistency for the 3-response group with general knowledge statements, and wished to test whether the advantage would be found reliably when response probability was factored out. On the basis of our working hypothesis we also expected to find that the

more personal statements about beliefs and aspirations would show no difference between the two groups. Finally, to test the generalizability of the results for General Knowledge in Experiment 1, a new set of test statements were sampled.

Experiment 3

Method

Participants. Forty-four students (35 female) at City University, London participated voluntarily. Some received course credits. They were randomly divided between the two conditions.

Materials. The booklets were created with 90 statements, comprising 30 general knowledge, 30 beliefs and 30 aspirations. The statements are listed in Appendix C. Beliefs and aspirations were devised partly with the help of a focus group of 5 students who were asked "what beliefs do you hold?" and "what are your aspirations in life?" Others were taken from current affairs news sources. For beliefs the aim was to provide a range of beliefs including some that most would hold, some that few would hold and some that were controversial issues where different opinions would be found. For aspirations there was again a mix of aspirations that most students would hold, aspirations that few would hold, and others that some would hold and others not. A new set of general knowledge statements were created with the aid of a quiz book. As in the previous Experiments, items with strong consensus are labelled Y and N in the Appendix. There were 4 such items for General Knowledge, 5 for Beliefs and 11 for Aspirations.

Design and Procedure. The design was the same as in Experiment 1, except that the 3 levels of the domain factor were general knowledge, beliefs and aspirations. The same instructions and response labels were used, again emphasizing that the "100% sure it's True" and "100% sure it's False" responses should only be used when the respondent was certain about the answer.

Results

Consistency of responding was calculated in the same way as in Experiment 1, for each of the 3 domains, and for each of the two groups. The data are summarized in Table 3 and mean consistency by condition is graphed in Figure 2. ANOVA was run on the consistency data, calculated as before, across subjects and items, with Type of Statement and Response group as factors. There were no significant main effects, but there was a significant interaction of Type of Statement with Response group (Min $F'(2,166) = 7.98$, $p < .001$). Breakdown analysis confirmed that the 3-response group was more stable than the 2-response group, only in the case of General Knowledge (Min $F'(1, 71) = 9.75$, $P < .005$) and not for the other two types of statement, where the 2-response group was slightly (although not significantly) more stable.

As in Experiment 2, an analysis was run to test whether the results were affected by a change in the distribution of items across the probability of categorization. As before, an ANCOVAR was run with modal response probability MRP as a covariate. The interaction of Domain by Response group was still significant ($F(2,263) = 4.58$, $p< .05$) when MRP was held constant as a covariate.

Discussion

Using a new sample of statements, Experiment 3 replicated the pattern of data found for general knowledge statements in Experiment 1. Furthermore it was possible to confirm that the pattern was not just owing to a redistribution of items in terms of probability of a True response in the 3-response group. In contrast, neither personal aspirations nor beliefs showed any greater consistency when the third response option was included. In keeping with our hypothesis, the personal nature of this type of information was such that our participants were unlikely to think “that is a belief or aspiration that I know nothing about”. As a consequence, the percentages of “unsure” responses that were repeated on the second occasion were just 58% and 77%, compared with 91% for the

knowledge questions.

Experiment 4

The final experiment to be reported extended the domains of knowledge tested to hedonic statements. Likes and dislikes are clearly a paradigm example of subjective personal facts. They are also clearly graded in as much as one can like or dislike things to different degrees. As such we expected that they would pattern like the other subjective statements used in Experiment 3, namely beliefs and aspirations. To test the generality of the findings we also introduced a change in the methodology. Rather than use two groups of participants, we combined the 2-response and 3-response conditions into a single task. Participants were offered four response choices. In this way three threshold criteria were incorporated into a single scale running from “100% sure it’s true”, and “Probably true but not 100% sure”, through “Probably false, but not 100% sure”, to “100% sure it’s false”. In this way the data could be collapsed into two response bins to test consistency in three different ways. Using a high threshold involved measuring the consistency of a “100% sure it’s true” versus any other response. The middle threshold measured the consistency of a true versus a false response, regardless of certainty; and the low threshold measured consistency for a “100% sure it’s false” as opposed to any other response. In addition to changing the design and response scale, a different mode of analysis was also used. The tetrachoric correlation coefficient (Drasgow, 1988; Ferguson, 1966) measures the degree of association in a 2x2 table. It is specifically suited to the situation in which each binary variable is the result of dichotomizing an underlying normally distributed variable. Each of these response variables is assumed to be correlated to the same degree with a single underlying latent variable, which is the “true” value of the item on the scale. The square of this underlying correlation is the tetrachoric correlation.

The tetrachoric model has three parameters which are estimated from the 3

degrees of freedom in the table, namely the dichotomization threshold of each response, and the degree of correlation between the two responses. It is the latter that we take as our measure of consistency. If there is greater consistency in deciding that something is 100% certainly true or false, than in deciding that it is simply true or false, then the two 2x2 matrices corresponding to a high and a low threshold will show higher values of the tetrachoric correlation than the 2x2 matrix that corresponds to the middle threshold.

Method.

Participants. Participants were 40 students at City University London, the majority of whom were female. Some additional participants who did not return for the second session were dropped from the study.

Materials. Thirty statements were created for each of three domains: Categorization, General Knowledge and Hedonic Likes/Dislikes. Three statements had to be dropped because of a printing error, so there were respectively 30, 28 and 29 statements in the three domains for the analysis. Category and Knowledge items were randomly sampled from those used in Experiment 1, with the addition of a new category "type of music". The Hedonic statements are listed in Appendix D. They were all phrased as "I like ….", and were generated with the help of a small group of students to reflect a range of tastes and aversions. Four of the Hedonic statements reached a positive consensus of 90% (students still like cookies and milk-shakes), and none reached a negative consensus at this level (see Appendix D).

Design and Procedure. The same procedure was used as in Experiment 3, with participants working through a booklet, and then returning after a period of approximately a week to do the task again. The response scale was however changed to incorporate four responses as described above. As a result the experiment was a single group design, with three domains of knowledge as a within-subjects factor, and the three measures of consistency taken at the three criteria (high, middle and low) as a second

within-subjects factor.

Results.

Response frequencies are summarized in a 4x4 cross-tabulation for each domain in Table 4. The data for each domain for each participant were collapsed into three 2x2 tables by setting a cut-off criterion at three different points on the response scale and collapsing all responses either side of the criterion. This procedure is illustrated in Figure 3. The resulting 9 data matrices (one for each threshold applied to each domain) were used to calculate 9 tetrachoric correlations for each participant. To avoid zero cell frequencies, 1 response was added to each of the four cells before the analysis. The analysis was performed on a Dell PC using TETCORR (Fleming, 2005) under Windows XP. Results are shown in Figure 4. The mean correlation reflects the degree of consistency in maintaining responses either side of each threshold criterion. It is clear that in the case of General Knowledge, but not in the other two domains, there was a lower consistency for the middle threshold (the simple True/False judgment) than for either of the other two. This conclusion was confirmed with an ANOVA with two repeated measures factors of Domain (Categories, Knowledge and Likes), and Threshold (High, Middle and Low). There was a significant main effect of Domain ($F(2,78) = 17.3$, $p < .001$, $MSe = .08$) and no effect of Threshold. However the interaction was significant ($F(2,78) = 5.6$, $p < .001$, $MSe = .016$). Breakdown analysis showed that there was an effect of Threshold for the General Knowledge statements ($F(2,78) = 15.206$, $p < .001$), but not for either of the other domains ($F(2,78) = 2.0$ for Categories and 0.6 for Likes). A further breakdown of the main effect of Threshold for the Knowledge statements showed that the consistency measure for the Middle threshold ($M = .77$) was significantly below both the High threshold ($M=.83$, $p < .05$) and the Low threshold ($M = .88$, $p < .001$).

Discussion.

Experiment 4 confirmed the pattern of results in earlier Experiments, that Categorization shows no difference in consistency between a True/False judgment and a Definitely True/ Not Definitely True or a Definitely False/ Not Definitely False judgment, whereas for General Knowledge statements there is such a difference. Our hypothesis that the lack of difference is primarily to be found in subjective domains was supported by the significant interaction showing that Hedonic likes and dislikes showed the same pattern as categorization, in contrast to the General Knowledge statements. A particular advance in Experiment 4 was the introduction of two innovations. First we used a single group of participants and combined the previous 3-response versus 2-response contrast into a single 4-response scale. Second we adopted a new method of statistical analysis using the tetrachoric correlation which is particularly suited to the analysis of this type of data. The confirmation of the earlier results with this different methodology confirmed the robustness of the results.

General Discussion

The central question of concern in this paper is the degree to which people are aware of the unreliability of their judgments. Are we sufficiently aware of the uncertainty in particular answers to the extent that we can reliably differentiate unclear cases from clear cases? The results of our experiments suggest that for many domains the answer is no. For categorization, autobiographical memories, beliefs, aspirations, and likes or dislikes, when participants differentiated the cases about which they were 100% sure from the rest, they were no more likely to give a consistent response at retest than if they were just forced to say “true” or “false” to each item regardless. *Prima facie* this result is counter-intuitive. It implies that when a person declares that they are “definitely 100% sure” that something is true, it is just as possible that they will change their mind in a week’s time as if they had simply said that on balance it was more likely to be true than false. In the following section we discuss each of the domains of

knowledge in turn.

For categorization decisions, the results across experiments provide clear support for the threshold model of category decisions (Hampton, 2007; Verheyen et al, 2010). In none of the experiments was there any indication that, as measured by consistency, second order vagueness (the point at which a statement ceases to be vague) is any less vague than first order vagueness (the point at which a statement ceases to be false). This result has important implications for the philosophical debate concerning the best way to treat vague statements. For example Kamp and Partee's (1995) treatment of vagueness using Fine's Supervaluations (Fine, 1975) requires that the borders of the region of vagueness are themselves less vague. (There is a risk of an infinite regress in which there is a region where the truth of a statement is vague, then there is vagueness about where that region itself begins, then vagueness about where the vagueness of the region begins, and so forth.) The result also suggests that explanations of fuzziness in categorization that rely on epistemological uncertainty (Bonini et al., 1999), or on contextual ambiguity (Braisby, 1993) would additional have to explain why people apparently show no awareness of their lack of knowledge or of the ambiguity of the task.

Of more direct psychological import, the results for categorization were contrasted with the way in which people responded to general knowledge statements. The intuition that there may be questions to which one confidently does not know the answer, and that this state of ignorance will remain stable across time was borne out by the results of Experiments 1, 3 and 4. For general knowledge statements there were clearly a number of items that were known unknowns, and hence a stable "unsure" response was given. The contrast between the two domains was also seen in the likelihood of the most extreme form of inconsistency, where a 100% Definitely True turned into a 100% Definitely False a week later (or vice versa). Looking at Tables 1 –

4, this pattern was seen in 7%, 6% and 4% of cases for the categorization domain across experiments, but in only 3%, 1% and 2% of cases in the general knowledge domain. Barsalou (1987) reported similar levels of shift in judgments of typicality within categories, with items that were most typical in week 1 sometimes being judged least typical a week or two later. It is probable that these two phenomena reflect the same cognitive process.

Could the observed difference between categorization and general knowledge in some way reflect a quantitative difference in the selection of items for testing, rather than some qualitative difference in the nature of the information and its processing? While impossible to rule such a difference out, we would argue strongly for a qualitative difference. First, a wide range of categories and items were sampled from the usual range of category norms, so the items were representative of conceptual categories (albeit with a preponderance of borderline cases). Second we tested two different sets of general knowledge statements, and the reader can confirm that there was nothing unusual in these items, some of which were easy and some hard (just as for categorization). Third, the use of different statistical measures, including an analysis of covariance in Experiments 2 and 3, ruled out the possibility of the observed interaction being owing to differences in the distribution of probability of “yes” or “definitely yes” responses across the item lists.

Having made this strong claim for categorization, we can be less confident as concerns the other “personal” information used in Experiments 1, 3 and 4. For these domains the sampling was less easy to control, and each domain was tested only once. Each domain (e.g. beliefs, aspirations etc.) was sampled in a relatively informal way, with the help of some pilot work. Failure to find a consistency advantage in the 3-response condition is therefore less secure as evidence about a fundamental difference in how the domain knowledge is processed. It was nonetheless striking that in each case

the group difference was significantly less than that for general knowledge, particularly bearing in mind that the significant Min F' statistic suggests that the effect is generalizable both to new participants and to new items.

Thus autobiographical statements of the kind used in Experiment 1 also showed very few known unknowns. This failure to find stable unknown items may relate to a phenomenon noted by Gentner and Collins (1981). They showed that we can reliably use the fact that we have no memory of an event to infer that the event did not occur. If asked "Did you ever shake hands with Richard Nixon", people can confidently know that they did not, simply because they have no recollection of the event, and *if it had occurred* then it is highly probable that they would remember it. Failure to find traces in autobiographical memory will be taken as evidence that a statement is false, whereas failure to find information about a general knowledge statement does not give any reason to believe that it is false. The implication is that for general knowledge as the level of retrieved relevant information decreases, responses tend to a stable "not sure" response, whereas for autobiographical memories, as the level of relevant information decreases, responses tend to a stable "false" response. The less a person can recall about ever being on a bus when it broke down, the more they will tend to believe that it definitely did not happen. Unlike general knowledge, lack of information about personal experiences will not lead to a known unknown.

As a consequence of the result with autobiographical statements, the hypothesis was formed that maybe the Rumsfeld Effect (the absence of known unknowns) occurs primarily in domains that involve personal information – a person's individual memories, beliefs, aspirations and likes or dislikes. Experiments 3 and 4 confirmed this hypothesis (subject to the caveats already mentioned). Once again, knowledge statements showed improved consistency when an "unsure" response was allowed, but statements involving personal beliefs and aspirations (Experiment 3) or hedonic likes

and dislikes (Experiment 4) did not.

Are there other domains than General Knowledge where known unknowns can be demonstrated? Other unpublished studies by the first author with Elizabeth Thwaites and with Priya Gorasia have found domains where consistency does improve with provision of an Unsure option. In the first study with Thwaites, participants judged whether unfamiliar words had particular meanings or not. Consistency across occasions was greater for the group who were allowed to say "Unsure", even for words that they claimed to have seen before, but of whose meanings they were unsure. In the second study with Gorasia, memory for a short video was tested on two occasions with a True/False recognition test. Again, the 3-response group showed better consistency than the 2-response group when it came to judging the truth or falsity of statements about the witnessed event. Both of these domains involve externally verifiable facts (word meanings and actual events), and so provide further confirmation of our hypothesis that the Rumsfeld Effect reflects a crucial distinction between more subjective and more objective domains of knowledge.

A model of fact verification

Our explanation of our results owes a debt to Glucksberg and McCloskey's (1981) analysis of the stages involved in verifying a fact. They proposed that first there is a search of memory for relevant information. If this search fails to find anything, then a quick "don't know" or "uncertain" response can be made. Alternatively if relevant information is retrieved, a slower "don't know" may still result, if the information proves insufficient to answer the question. The present results for knowledge statements are consistent with this general model, and additionally suggest that a "don't know" arising in the first stage from the lack of relevant information is a more stable response than one arising from the second stage. When memory contains no relevant information, then participants in the 3-response condition can reliably state that they are unsure. The

following week there is still no information in memory, and so they come up with the same answer. Those unfortunate enough to be in the 2-response group have to use some other means of guessing the answer, and so risk changing their mind the following week.

To explain the results for categorization and for personal information, it is suggested that in these domains memory will almost *always* contain relevant information. A statement about your past experiences or future ambitions may be more or less meaningful to you, but you will always have some relevant basis in memory on which to base your answer. In this case it is a question of trying to retrieve evidence and argument in favour of the statement being true or not. Would you like to meet the Queen (of England)? You think of the pros and cons and weigh them up in your mind. The consequence of this slower process is that you accumulate a degree of confidence in the answer being true, and then compare this to some threshold criterion. In the case of a "definitely true" answer, the criterion is higher than just for a "true" answer. But in both groups, the participant is doing the same thing – accumulating reasons for the statement being true or false, and then deciding if the threshold is passed. They do not decide that there are no reasons either way, so that no decision can sensibly be made.

If this account is correct, then we would predict that there may be some cases of category membership and some autobiographical memories and other personal information that *would* show greater consistency in the 3-response condition. If a category item was so unfamiliar as to be unknown to the participant – for example it might be whether euglena is an animal (Hampton, 1998) – then it could end up being given a stable "unsure" response. Similarly if asked to evaluate a memory such as "On 11 November 2004 I wore a blue shirt", (and assuming that the person did regularly wear blue shirts at the time) then again a consistent "unsure" response could be generated. For other personal domains, a statement of belief about some unknown

practice (e.g. the ethics of Finland's whaling policy) would likely also engender stable unsure responses, as would aspirations for unknown goals (I would like to take a vacation in Carvoeiro). In such cases, the initial attempt to retrieve relevant information would fail to find any reason for giving either a True or a False response. The pros and cons would never be evaluated against a criterion, and so the response of "unsure" would be more stable.

The Rumsfeld Effect is the finding that there are "unknown unknowns – the ones we don't know we don't know". We claim that when a decision is made by accumulating evidence and comparing it to a criterion then responses of "sure" and "unsure" are like unknown unknowns. We cannot access a stable state of uncertainty in a reliable fashion. It is known that people are overconfident, judging that they are 100% certain about things, 10% of which they have got wrong (Fischhoff et al., 1977). The contribution of the present research is to show that for personal domains of knowledge the belief that one is 100% confident that something is definitely true is a surprisingly unstable mental state.

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Author Notes

Address all correspondence concerning this article to James A. Hampton, Department of Psychology, City University, Northampton Square, London EC1V OHB, UK. Email: hampton@city.ac.uk. We thank Priya Gorasia, Gurinder Jai and Elizabeth Thwaites for their help in developing this research.

Footnote

1. It is of course possible that one or more of the autobiographical events may have occurred to participants in the intervening week. The likelihood of this was considered very low, and would in any case affect consistency in both conditions.

2. Low response probability leads to greater predicted consistency because of the way consistency was calculated. The repetition of any response other than the designated response was counted as consistent. Thus if Definitely True had a low probability, {Either Not sure Or Definitely False} had a high probability and so was likely to be repeated. Hence the predicted consistency of a Definitely True response would paradoxically increase as the probability of that response decreased. This issue is address in more detail in subsequent experiments.

APPENDIX A. Statements used in Experiment 1

Note: (Y) and (N) indicate items receiving >90% True, or >90% False responses respectively in the 2-response condition.

CATEGORY STATEMENTS

An apple is a fruit (Y)

An avocado is a fruit

A carrot is a fruit

A coconut is a fruit

A grape is a fruit (Y)

A mushroom is a fruit (N)

An olive is a fruit

Rhubarb is a fruit

A tomato is a fruit

A walnut is a fruit

An artichoke is a vegetable

Bamboo shoots are a vegetable

A cereal is a vegetable

Garlic is a vegetable

Lettuce is a vegetable (Y)

A peanut is a vegetable (N)

Sage is a vegetable

Seaweed is a vegetable

A turnip is a vegetable

Billiards is a sport

Bullfighting is a sport

Chess is a sport

Darts is a sport

Hunting is a sport

Kite flying is a sport

Mountaineering is a sport

Playing cards is a sport

Teaching is a sport (N)

Washing dishes is a sport (N)

An axe is a tool

A bottle is a tool

A bucket is a tool

A pen is a tool

A rake is a tool

A sewing needle is a tool

A tire is a tool

A toothbrush is a tool

An umbrella is a tool

Varnish is a tool

A chair is furniture (Y)

A cushion is furniture

A desk is furniture (Y)

A door mat is furniture

A lamp is furniture

A piano is furniture

A remote control is furniture (N)

A rug is furniture

A saucepan is furniture

A wastebasket is furniture

GENERAL KNOWLEDGE

A common side effect of antidepressants is itching skin rashes

Adidas produces more shoes than Reebok

Aikido is a Japanese martial art where one often practices with wooden sticks

Aliens control people's minds (N)

Astronauts wear spacesuits when taking a walk outside spaceships

Bicycles do not have wheels (N)

Black and Green tea have generally equally amounts of caffeine in them

Britain produces more meat than grain

Certain sounds can be very loud (Y)

Everything shown on the TV is true (N)

Green tea can enhance reaction time

Humans are 60-65% water

If climate change accelerates the Mediterranean will dry out within 85 years

If you faint standing up you are more likely to land on your back than on your front

In England cars drive on the left (Y)

In humans the spleen is larger than the liver

In parts of Africa there are still dinosaurs (N)

In the winter Canada is colder than Finland

John is the most common name in Britain

Lizard tastes like chicken (N)

London has more than 11 airports

Mongolia is a country (Y)

Music is something edible delivered in boxes (N)

No vehicle can go faster than the speed of light

North Korea is larger than South Korea

Olives are more popular in Greece than in Italy

People living in arctic conditions can breathe under water (N)

Platinum is more expensive than diamond

Sausages from Germany and sausages from Austria taste about the same

Scandinavia is formed by five countries

Sharks have been developing for millions of years

Snow falls from the sky

Some boats have motors others have sails (Y)

Some poisonous plants can induce prolonged coma in humans

Texas is the size of Oklahoma

The earth is flat (N)

The Internet was originally developed for military reasons

The official language of Sweden in Swedish

The pope's name is George W. Bush (N)

The price of a cup of coffee at Starbucks is more than 100 pounds (N)

The Rosetta stone contains Egyptian, Greek and Persian writing

The Saxons used lengths of copper thread as a method of payment

The sea is deep in some places (Y)

The Uruguayan flag has red in it

The world ended on the millennium (N)

The world's largest garage is in Los Angeles

There are countries bigger than the UK (Y)

There are more than 15,000 habitants in London

Vikings used to live in Scotland

AUTOBIOGRAPHICAL

During the last two years I have been to at least one fancy dress party

Growing up I was often ill

I am a certified pilot (N)

I eat more sweets during the weekend

I have a brother

I have been downhill skiing in the Alps (N)

I have been on the Jerry Springer show (N)

I have been to a Robbie Williams concert (N)

I have been to the Niagara Falls

I have bought a lottery ticket at least once

I have broken a leg (N)

I have called a close family member by the wrong name (Y)

I have eaten four bowls of cereal in one day

I have experienced heavy rain and bright sunshine at the same time

I have had bad luck on a Friday the 13th

I have met a celebrity

I have never participated in a world cup

I have prepared a dish with spring onions

I have prepared and served shark soup (N)

I have read a book with more than 450 pages (Y)

I have read parts of Homer's Iliad

I have seen a living raven up close

I have seen a meteor hit the ground (N)

I have seen a very skilful magician.

I have seen two traffic accidents in one day

I have stayed in a hotel (Y)

I have swum with dolphins (N)

I have used a blue notebook

I have visited two museums in one day

I have witnessed a purple sunset

I have worn a grey hat

I know someone who has been to Australia (Y)

I once burned a shepherd's pie in the oven

I once had the flu for more than two weeks

I once owned a pair of yellow sneakers (N)

I once owned a teddy bear (Y)

I studied a second language in school (Y)

Last year there was more sun than this year

My birthday is in July (N)

My blood group is AB

My mother is named Anne-Marie (N)

Once I bought fruit that was out of date

Once I forgot to lock my front door

Once I got oil stains on my new jeans

Once I made a huge bargain at a second hand shop

Once I received a parcel in the post

Once I was rescued by a fireman from a burning house (N)

Once I woke up in the middle of the night startled by loud birds

Once I wrote a short story (Y)

Appendix B: Categories and Category Items used in Experiment 2

Note: (Y) indicates >90% yes responses, (N) indicates >90% no responses in the 2-response condition

FRUIT	VEGETABLE	SPORT	SCIENCE	TOOL	FURNITURE
almond (N)	artichoke	aerobics	advertising (N)	axe (Y)	ashtray
apple (Y)	asparagus (Y)	dancing	agriculture	book (N)	book
aubergine (N)	bamboo shoot	billiards	archaeology	bucket	bookends
avocado	celery (Y)	bridge	architecture	calculator	bucket (N)
banana (Y)	cereal (N)	bullfighting	astrology	dictionary	curtains
carrot (N)	chili pepper	chess	criminology	funnel	cushion
coconut	cloves	croquet	dentistry	hammer (Y)	desk (Y)
cucumber	dandelion	crosswords (N)	economics	key	dishwasher
ginger (N)	garlic	darts	geography	pen	door mat
mushroom (N)	lettuce (Y)	fishing	geometry	pitchfork	lamp
olive	mint	footballing (Y)	literature	rake	painting
onion (N)	mushroom	frisbee	mathematics	scalpel (Y)	piano
orange (Y)	parsley	hiking	medicine (Y)	scissors (Y)	pillow
pine cone	peanut (N)	hunting	meteorology	screw	plate (N)
pomegranate (Y)	potato (Y)	jogging	mineralogy	sewing needle	refrigerator
pumpkin	rice	kite flying	nutrition	stone	rug
rhubarb	sage	mountaineering	palm reading (N)	string	shelf (Y)
strawberry (Y)	seaweed	playing cards (N)	pharmacy (Y)	toothbrush	suitcase (N)
sugar beet	soybean	skiing (Y)	philosophy	tractor	table (Y)
tomato	spinach (Y)	surfing (Y)	psychology	trunk	telephone
walnut (N)	turnip	tennis (Y)	religious studies (N)	umbrella	television
watermelon (Y)	watercress	weightlifting	sociology	varnish	waste basket

Appendix C: Statements used in Experiment 3

Note: Items marked (Y) and (N) received respectively >90% Yes, and >90% No answers in the 2-response condition.

ASPIRATIONS

I aspire to be on TV. (N)

I aspire to have a successful and secure career.

I aspire to meet the Queen. (N)

I hope to fight for my country.

I hope to pursue an acting career in the future. (N)

I hope to pursue my passion for singing in the future. (N)

I hope to start my own business.

I want to do a parachute jump.

I want to have children one day. (Y)

I want to swim with dolphins.

I would like shake hands with the Prime Minister. (N)

I would like to be retired by the age of 60.

I would like to climb Mount Everest.

I would like to do a bungee jump.

I would like to get married one day.

I would like to have a wax model of myself in Madame Tussauds. (N)

I would like to have the opportunity to work abroad.

I would like to help people who are less fortunate than me. (Y)

I would like to meet my favourite celebrity.

I would like to migrate to another country in the future.

I would like to win the lottery.

It is my ambition to become the Prime Minister. (N)

It is my ambition to have political power.

It is my ambition to learn to play a particular instrument one day.

It is my ambition to own a house one day. (Y)

It is my ambition to play for my favourite football team. (N)

It is my ambition to run the marathon.

It is my ambition to study further than degree level.

It is my ambition to travel into space.

It is my ambition to travel the world.

BELIEFS

A father figure is important in a child's life. (Y)

Abortion is acceptable.

Animal testing is wrong.

Children aged between 10-16 years should be allowed to testify in court.

Children should always grow up in contact with both of their biological parents.

Couples who live together before marriage are committing a sin.

Divorce is unacceptable.

Freedom of speech is vital to have in society. (Y)

Heaven and Hell exist.

Honorary killings are sinful. (Y)

I believe in a particular religion.

I believe in God.

It is acceptable to have breast implantation if it will boost self confidence.

It is acceptable to use contraception. (Y)

It is justifiable to lie under certain circumstances.

It is possible to contact the dead.

It is safe to travel on the London Underground after the 7/7 attack.

Life sentences should be given to all offenders who have committed a murder.

Madeleine McCann's parents are at fault for her disappearance.

Muslims are fairly portrayed in the media.

Religion is important.

Same-sex couples in a stable relationship should be allowed to marry.

Same-sex partners should be allowed to raise children.

Sex before marriage is acceptable.

Sex changes are a sin.

Smacking children is unacceptable.

The death penalty is wrong.

The man should always be the primary bread winner.

There is reincarnation after death.

Women often still face gender discrimination in the work place. (Y)

GENERAL KNOWLEDGE

14 men have walked on the moon.

4 teaspoons make up 1 tablespoon.

An emerald wedding anniversary is celebrated after 55 years.

Chromophobia is the fear of colours.

GI normally stands for Government Issue.

If Prince William became King, he would be William the 5th.

In Roman numerals 555 is displayed DLV.

India is the country with the most number of Universities. (N)

India's national symbol is a lotus flower.

Indonesia has the largest Muslim population.

Jim Davis created the cartoon cat Garfield.

Margaret Thatcher was the last Prime Minister not to have a wife.

Prior to 1664, New York was called New Amsterdam.

Richard Nixon made the first phone call to the moon.

Starbucks is named after a character in Moby Dick.

The 'e' in 'e-mail` stands for electronic. (Y)

The 'mp' in mp3 players stands for moving picture.

The American flag has 50 stars.

The clothes logo DKNY is short for Donna Karan New York.

The first e-mail was sent in 1962.

The First Lord of the Treasury is the Prime Minister. (Y)

The first tea bags were made by Tetley.

The French flag has blue in it. (Y)

The leader of the Orchestra plays the cello.

The title of the person who gives the results of elections is the Returning Officer.

The translation of Volkswagen is 'People's car'.

The Union Jack is an alternative name for the Union Flag.

The V in DVD stands for versatile.

The word 'safari' originates from the language of Swahili.

There are 30 individual pieces in a set of dominoes.

Appendix D: Likes and Dislikes Statements used in Experiment 4

Note: Items marked (Y) received >90% Definite or Probably Yes responses. No items had >90% No responses.

I like listening to classical music

I like watching cricket

I like pizza (Y)

I like Kate Moss

I like Robert Mugabe

I like Tom Cruise

I like George Clooney

I like watching golf

I like Prince William

I like listening to opera music

I like Will Smith

I like Beyonce

I like watching tennis

I like spinach

I like Nelson Mandela

I like Brad Pitt

I like pasta (Y)

I like George W Bush

I like Naomi Campbell

I like Nicole Kidman

I like milkshake (Y)

I like listening to rock & Roll music

I like listening to jazz music

I like chocolate cookies (Y)

I like watching basketball

I like Tony Blair

I like listening to R'n'B music

I like Angelina Jolie

I like Sarah Palin

Table 1: Percentage of response combinations for each type of statement in Experiment 1.

TWO-RESPONSE CONDITION		Second response			
Type of statement	First response	TRUE	FALSE	Total	% Consistent
Category	TRUE	47	9	56	84%
	FALSE	9	35	44	80%
Knowledge	TRUE	38	7	45	85%
	FALSE	11	44	55	80%
Autobiographical	TRUE	39	5	44	88%
	FALSE	7	49	56	88%

THREE-RESPONSE CONDITION		Second response				
Type of statement	First response	100% TRUE	Not 100% sure	100% FALSE	Total	% Consistent
Category	100% TRUE	36	6	5	47	77%
	Not 100% sure	7	16	7	30	54%
	100% FALSE	2	4	17	23	73%
Knowledge	100% TRUE	19	3	2	24	79%
	Not 100% sure	4	44	6	54	81%
	100% FALSE	1	2	19	22	88%
Autobiographical	100% TRUE	34	3	3	40	86%
	Not 100% sure	3	9	4	16	53%
	100% FALSE	4	4	36	44	81%

Note: the actual response options were “100% sure it’s true”, “Not 100% sure either way”, and “100% sure it’s false”.

Table 2: Percentage of response combinations for categorization test and retest in Experiment 2.

TWO-RESPONSE CONDITION	Second response			
First response	YES	NO	Total	% Consistent
YES	45	7	52	86%
NO	9	39	48	80%

THREE-RESPONSE CONDITION	Second response				
First response	Definite YES	MAYBE	Definite NO	Total	% Consistent
Definite YES	37	6	3	46	80%
MAYBE	4	10	5	19	54%
Definite NO	3	6	26	35	73%

Table 3: Percentage of response combinations for each type of statement in Experiment 3.

TWO-RESPONSE CONDITION		Second response			
Type of statement	First response	TRUE	FALSE	Total	% Consistency
Aspirations	TRUE	38	6	44	87%
	FALSE	3	53	56	94%
Beliefs	TRUE	60	5	65	93%
	FALSE	4	31	35	89%
Knowledge	TRUE	40	8	48	84%
	FALSE	11	41	52	79%

THREE-RESPONSE CONDITION		Second response				
Type of statement	First response	100% TRUE	Not 100% sure	100% FALSE	Total	% Consistency
Aspirations	100% TRUE	37	4	1	42	88%
	Not 100% sure	5	16	6	27	58%
	100% FALSE	1	4	26	31	85%
Beliefs	100% TRUE	41	3	2	46	88%
	Not 100% sure	5	24	2	31	77%
	100% FALSE	3	4	16	23	71%
Knowledge	100% TRUE	16	2	0	18	90%
	Not 100% sure	3	59	3	65	91%
	100% FALSE	1	6	10	17	85%

Table 4: Response frequencies for the four responses in Experiment 4, rounded to nearest integer. (See text for wording of responses.)

		Second response					
Type of statement	First response	100% TRUE	Probably false	Probably true	100% FALSE	Total	% Consistency
Categories	100% TRUE	38	10	4	2	54	71%
	Probably true	6	9	4	2	21	41%
	Probably false	1	5	4	4	14	30%
	100% FALSE	2	1	4	6	12	46%
Knowledge	100% TRUE	26	4	2	1	32	80%
	Probably true	5	15	6	1	27	56%
	Probably false	1	5	7	2	14	46%
	100% FALSE	1	1	2	23	26	87%
Likes	100% TRUE	31	6	3	3	43	72%
	Probably true	4	7	2	1	14	48%
	Probably false	1	3	7	2	13	52%
	100% FALSE	3	2	5	20	30	68%

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Figure captions

Figure 1: Mean Consistency by Condition for the Three Types of Statement in Experiment 1. Error bars show 95% CI.

Figure 2: Mean Consistency by Condition for the Three Types of Statement in Experiment 3. Error bars show 95% CI.

Figure 3: Illustrating the creation of three 2x2 matrices from the 4x4 response matrix in Experiment 4. A to D are the four possible responses, 1 to 16 the cell frequencies. Shaded squares are summed to yield consistent responses for each 2x2 matrix.

Figure 4: Mean tetrachoric correlation across participants in Experiment 4 for three levels of threshold in three domains. Error bars show 95% CI.

Figure 1:

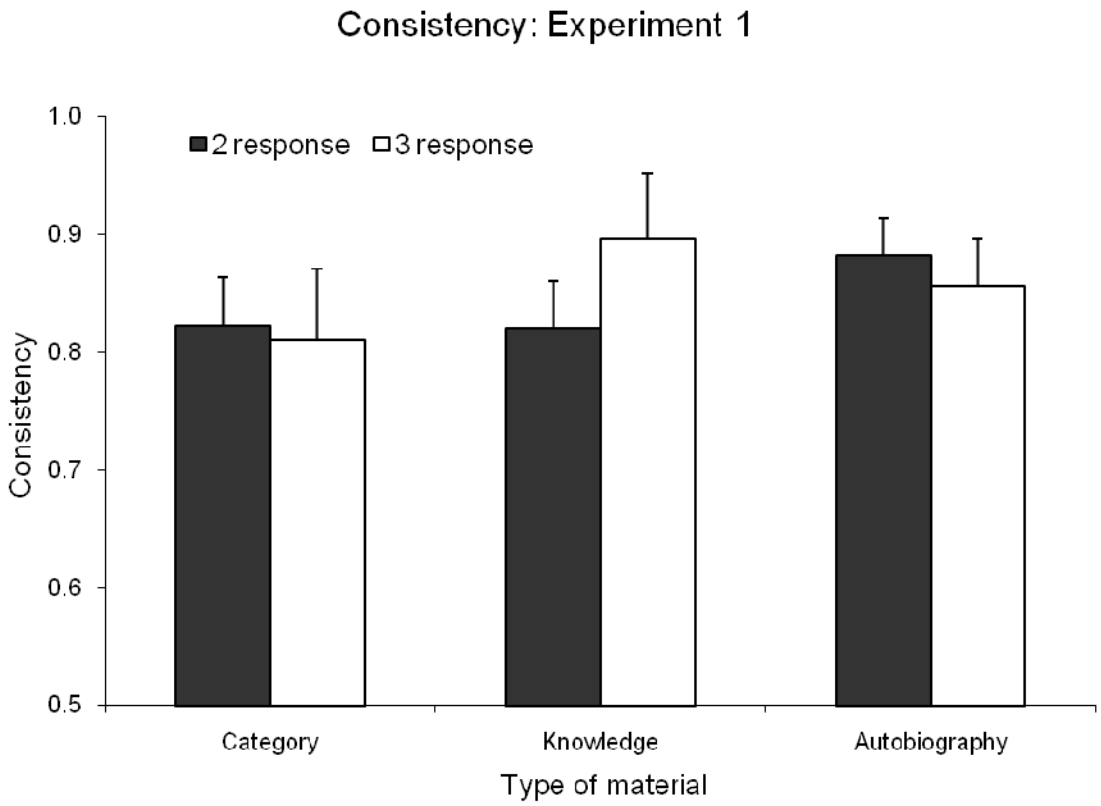

Consistency: Experiment 1
2 response
3 response
Consistency
1.0
0.9
0.8
0.7
0.6
0.5
Category
Knowledge
Autobiography
Type of material

Figure 2

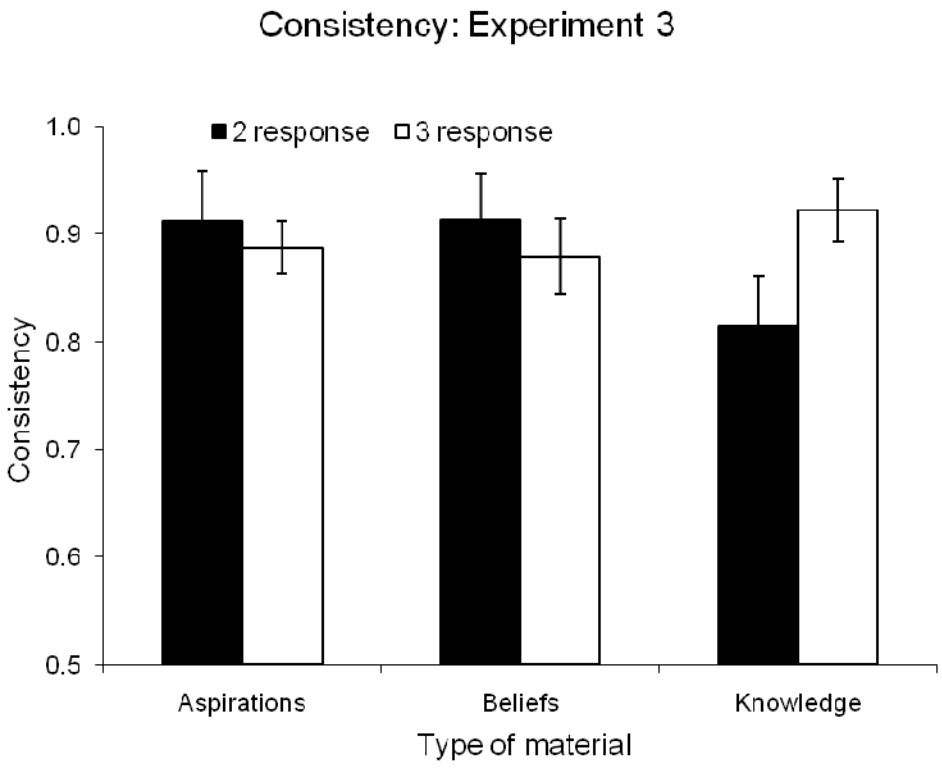

Consistency: Experiment 3
2 response
3 response
1.0
0.9
0.8
0.7
0.6
0.5
Consistency
Aspirations
Beliefs
Knowledge
Type of material

Figure 3

		Second Occasion			
		A	B	C	D
First Occasion	A	1	2	3	4
	B	5	6	7	8
	C	9	10	11	12
	D	13	14	15	16

High threshold matrix matrix

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

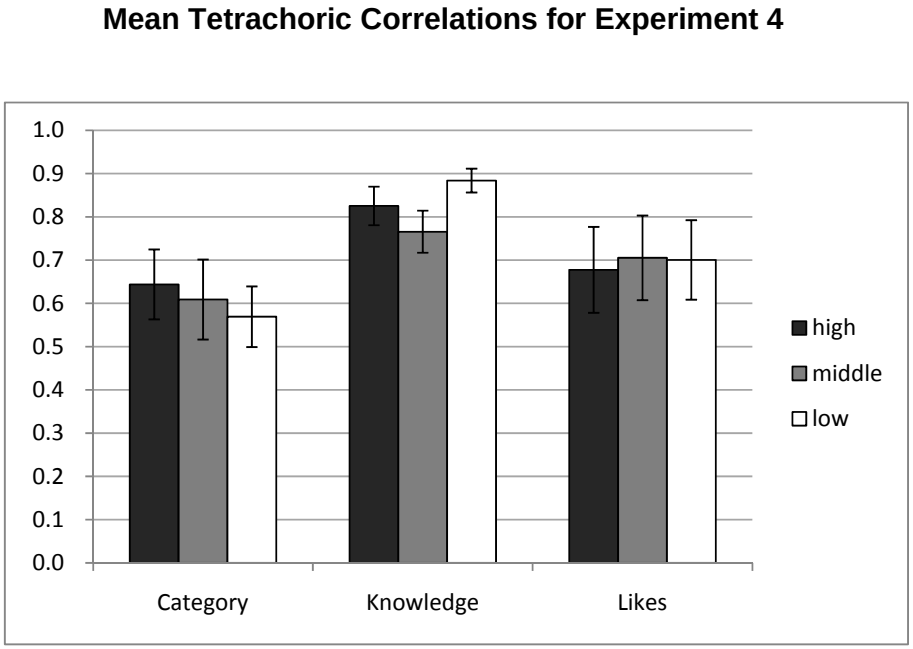
Middle threshold matrix

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Low threshold

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Figure 4


Mean Tetrachoric Correlations for Experiment 4
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Category
Knowledge
Likes
high
middle
low