PERCEIVED SUBJECTIVITY AND GRADEDNESS OF ARTIFACTUAL AND NATURAL CATEGORIES

by

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(Under the Direction of Zachary Estes)

ABSTRACT

The question of whether beliefs of subjectivity account for differences in the gradedness of artifactual and natural categories was examined. Two studies established a relation between perceived subjectivity and category gradedness: Whereas beliefs of subjectivity (i.e., matter of opinion) corresponded to an increase in graded (i.e., continuous) category judgments, beliefs of objectivity (i.e., matter of fact) corresponded to an increase in absolute (i.e., discrete) category judgments. Individual differences in perceived subjectivity also demonstrated a positive relation of perceived subjectivity and category structure. In addition, two experiments tested a potential causal relation of perceived subjectivity and gradedness. Perceived subjectivity was manipulated as a contextual variable and category gradedness was measured across conditions. Results from two experiments replicated prior findings of a domain difference in category structure. However, evidence of a causal relation between perceived subjectivity and gradedness was not established. The finding of positive relation of perceived subjectivity and category structure supports theory-based representation and essentialist beliefs in categorization.

INDEX WORDS: concepts; category structure; semantic category membership; artifactual categories; natural categories; gradedness; domain differences; essentialist beliefs; subjectivity

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CHAPTER 1

INTRODUCTION

Human categorization is a fundamental cognitive ability. Concepts are organized into coherent knowledge structures to extrapolate meaning of the natural environment (e.g., Mervis & Rosch, 1981; Murphy & Medin, 1985; Rosch, 1978). Moreover, categorization aids in object recognition (Smith & Medin, 1981), prediction (Heit, 2001; Murphy, 2002), inductive reasoning (Osherson, Smith, Wilkie, López, & Shafir, 1990; Rips, 1975), and explanation (Murphy & Medin, 1985). Categories also serve to communicate information among individuals (Malt, 1990; Putnam, 1975). In short, categorization is a flexible process, allowing for the retrieval of mental representations and the selection of appropriate responses. The need to categorize is therefore a pervasive phenomenon in human cognition.

Early theories of categorization proposed that category membership is based on similarity (e.g., Medin & Schaffer, 1978; Mervis & Rosch, 1981; Rosch, 1978; Rosch & Mervis, 1975). That is, categorization entails a comparison between a to-be-categorized object and a category prototype or set of exemplars. The extent to which the object is similar to the prototype (i.e., ideal representation), or set of exemplars, determines whether that object belongs in the given category. Given this account, if categorization is based on similarity, and similarity is graded (i.e., a matter of degree), category membership must also be graded. For instance, an *apple* is generally considered a better member of the category FRUIT than a *tomato.* That is, objects may partially belong to a category and category membership may be unequal (Mervis & Rosch, 1981).

Research, however, has proposed an alternative account of categorization (Murphy & Medin, 1985). Specifically, categorization is based on one's theoretical beliefs of artifactual (e.g., furniture) and natural objects (e.g., fruit). Whereas natural categories are believed to be objective, artifactual categories are believed to be subjective (Hampton, 1998; Kalish, 1995, 2002; Malt, 1990). In addition, natural objects tend to be categorized absolutely, whereas artifactual objects tend to be categorized as a matter of degree (Diesendruck & Gelman, 1999; Estes, 2003).

This differential categorization of artifactual and natural objects is theoretically consistent with the different beliefs about those domains. Whereas an objectivist belief implies absolute categorization, a subjectivist belief implies graded categorization. Therefore, beliefs of objectivity and subjectivity may predict the categorization of artifacts and natural kinds. Little research, however, has investigated how people's epistemic beliefs of artifactual and natural categories directly influence their categorization behavior. Therefore, the goal of this paper is to examine the influence of perceived subjectivity on the categorization of artifactual and natural categories. In what follows, I review similarity-based and theory-based representations of categorization. I discuss psychological essentialism, a variant of theory-based representation, and review methods used to investigate the role of epistemic beliefs on categorization. In addition, I include two studies and two experiments designed to address the question of whether people's beliefs influence their category judgments.

Similarity-Based Representation

Resemblance theories (i.e., prototype theory, exemplar theory) have traditionally relied on similarity-based representation as an explanation for classification (Medin & Schaffer, 1978; Nosofsky, 1986, 1992; Rosch, 1978). Similarity refers to the weighing of common (i.e., matching) and distinctive (i.e., mismatching) features in terms of importance (Tversky, 1977). Similarity is a summative process; the weights of matching features are added, whereas the weights of mismatching features are subtracted. Hence, a concept is judged to belong in a category if the number of weighted features exceeds a certain threshold for category membership.

According to prototype theory, concepts are grouped together by correlated features that differentiate artifactual and natural categories (Rosch, 1978). In addition, within a given category, there are correlations among features. For instance, consider the category BIRDS. Within this category, *having feathers* is correlated with *having wings* and the *ability to fly*. These inter-correlations allow for the formation of a category prototype, which is an idealized category member containing all of the correlated features within a given category (Rosch, 1978). Prototypes therefore reflect an intensional representation of a category because it contains a set of features that characterize the prototype. In addition, prototypes serve as a metric for comparison by establishing a threshold criterion for category membership (Hampton, 1993, 1998). Thus, category membership is determined by comparing an instance to the category prototype. If the instance is deemed to be sufficiently similar to that prototype, it is thus classified as belonging to that particular category.

In the same regard, exemplar models posit a similarity-based approach to categorization. Instead of representing a category prototype, however, categories are represented by their specific instances (Lamberts, 1994; Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1986). That is, classification is based on the retrieval of a subset of stored exemplars. From this perspective, categorization is based on a comparison between an instance and the subset of previously learned exemplars. If the to-be-categorized object is considered to be similar to those category exemplars, it is classified as a category member.

To be sure, previous research has tested the predictions made by prototype and exemplar models. In general, there is greater evidence in support of exemplar-based models (Medin & Coley, 1998; Nosofsky, 1992; Nosofsky & Palmeri, 1997). For instance, exemplar models better account for the use of category induction and prediction than prototype models. Because exemplar models involve a comparison with a set of exemplars, information about category size, context sensitivity, and instance variability are preserved in making category judgments (Medin, 1989; Medin & Ross, 1989; Nosofsky, 1986). Although the general consensus is that exemplar models fare better than prototype models in categorization, the important point to address is that both theories rely on similarity-based representation.

Problems with Similarity

In a seminal paper, Murphy and Medin (1985) argued that similarity insufficiently accounts for categorization. One argument against this view is that similarity places too much emphasis on the relative weightings of individual features. The implication is that two grossly discrepant concepts may appear to be more similar if sufficient weight is given to a particular feature. For instance, a ZEBRA may appear to be more similar to a SKUNK than a HORSE if enough weight is placed on the 'striped' feature. Another argument against similarity is the issue of designating what constitutes a relevant feature. A TOMATO, for instance, may be regarded similarly to a CUP in that both weigh less than a ton. Thus, any two concepts may be infinitely similar (or dissimilar) depending on the criteria used to determine a relevant feature (Goodman, 1972; Murphy & Medin, 1985).

Moreover, similarity-based representation does not adequately explain gradedness for abstract (Hampton, 1981) or goal-derived categories (Barsalou, 1983, 1987). Abstract categories (e.g., ART) are nearly limitless in the number of instances that can be produced. Greater independence of features in abstract categories also decreases the correlational structure of features in concept representation (e.g., Rosch, 1978). Hence, the internal structure of abstract categories does not reflect prototypical structure found in concrete categories (e.g., FRUIT). Likewise, the internal structure of goal-derived categories is not centered on similarity to a prototype. Instead, goal-derived categories are based on similarity to an ideal, which refer to conceptual features that satisfy a goal associated with a particular category. For instance, consider the category THINGS TO TAKE TO THE BEACH. Probable category members may include sunscreen and flip flops because those exemplars best reflect that category's goals, although they are perceptually distinct. Hence, similarity inadequately places constraints on determining the nature of concept representation and classification (Murphy & Medin, 1985).

Similarity also does not address the role of background knowledge and domain theories in categorization. Background knowledge and domain theories reflect people's beliefs about the interrelations and causal relations among features and concepts (Murphy & Medin, 1985). These underlying beliefs about the nature of the category are thought to constrain the salience of individual features in order to determine category membership. For instance, people generally expect natural kind categories to have an underlying biological relation and artifactual categories to have an underlying functional relation (Bloom, 1998; Keil, 1989; Rips, 1989). Similarity-based representation ignores the relational constraints and use of background knowledge in categorization. Thus, in recent years, theory-based representation has been posited as an alternative account of categorization.

Theory-Based Representation

In contrast to similarity-based representation (e.g., Rosch, 1978), theory-based representation considers the role of people's beliefs and knowledge in concept representation (Murphy & Medin, 1985). From this perspective, classification is not based on a comparison between matching features of a concept. Instead, categorization is based on providing the best explanation for classification. Moreover, a *theory* refers to the use of causal knowledge, rules, and relational information about a set of concepts; it does not necessarily refer to a formal scientific explanation. These explanations impose constraints on which properties are used in concept representation. That is, theory-based representation posits that correlated features are used to the extent that one's theory relates to those features. The central idea is that there is an underlying causal relation used to explain the connection across category features. Hence, classification is more of an inferential process rather than a similarity judgment.

In support of theory-based representation, researchers have shown that prior knowledge influences category learning (Heit, 1994, 1998; Pazzani, 1991; Wisniewski & Medin, 1994). That is, knowledge may be used to help learners infer important features and form expectations about novel categories. Murphy and Allopenna (1994) examined whether category learning improves when exemplar features shared a thematic relation. In the thematic condition, exemplar features (i.e., *made in Africa*, *has wheels*) were consistently related to form a coherent category theme (i.e., JUNGLE VEHICLE), in contrast to the neutral condition, whose features (i.e., *green*, *air bags*) did not form a coherent category theme. Category structure across conditions was constant despite whether category properties formed a thematic set. They found that participants learned categories with greater facility in the thematic condition than in the neutral condition. Thus, learning improves when features share a thematic relation within a category.

In real-world situations, however, it is arguably the case that prior knowledge does not relate to every conceptual feature; instead, a number of exemplar features may not relate to one's prior knowledge (Kaplan & Murphy, 2000). A person, for instance, may have an explanation for why BIRDS have *wings*, but they may not have an immediate explanation for why BIRDS have *beaks*. In this case, prior knowledge may not facilitate category learning when features are not thematically related but are instead learned by rote. Therefore, to test whether minimal background knowledge affects category learning, Kaplan and Murphy selected items containing several features. For each item, only one feature (e.g., *get there by submarine*) was thematically related to a category (e.g., UNDERWATER BUILDINGS). In addition, items were organized into two conditions to form an intact thematic set or a mixed thematic set. In the intact thematic set, all of the items created one category theme, whereas in the mixed thematic set, half of the items from one category theme were grouped with half of the items from the other category theme. In order to derive the correct category theme, participants had to integrate the related feature across items. Kaplan and Murphy found that prior knowledge aided in category learning even when each item contained only one knowledge-related feature. In particular, category learning improved when each category member shared one theme (intact thematic set) in comparison to the category that shared multiple themes (mixed thematic set). This facilitative effect for the intact thematic category was found even when participants classified features under speeded conditions (Experiments 2 and 4). Moreover, this result could not be attributed to an interference effect in the mixed thematic set (Experiment 3). In that experiment, the mixed thematic set was compared with a neutral category that did not contain relational features. Using a speeded categorization task from Experiment 2, no differences between the mixed and neutral categories were found. This null result suggests that inconsistent knowledge from the mixed category did not impede category learning. Instead, these findings suggest that with minimal prior knowledge, people integrate relational information across several category members to form coherent themes that facilitate category learning.

Therefore, given that prior knowledge is used to select relevant category properties for classification (Kaplan & Murphy, 2000), the implication is that different knowledge structures may result in differential categorizations using identical objects. To illustrate, Kelemen and Bloom (1994) presented a set of circles with varying colors and sizes to participants. The circles were described as either ANIMALS or MACHINES. Participants were asked to classify the circles and justify their responses. They found that the circles were classified by color when described as ANIMALS, but were classified by size when described as MACHINES. In addition, participants indicated that color was more important for classifying ANIMALS because color is relevant for pigmentation, whereas in classifying MACHINES, size is relevant for machine function. Thus, Kelemen and Bloom found differences in category judgments as a function of maintaining different background knowledge.

As another example, Lin and Murphy (1997) examined whether differences in background knowledge influence the categorization of well-learned concepts. Across several experiments, groups of participants learned different aspects about the role and function of a foreign artifact. For instance, in one condition, the object was described as a tool used for hunting, whereas in the other condition, the object was described as a fertilizing tool. In addition, features critical to the function of one category (e.g., hunting) were not critical to the function of the other category (e.g., fertilizing), although the descriptions referred to the same parts of the object. Therefore, participants embodied different background knowledge structures about the same foreign object. At test, all participants viewed similar artifacts missing one or more parts from the original item. The removal of those parts was designed to be a critical feature for one category but an unimportant feature for the other category. Lin and Murphy found that category responses depended on the initial learning of the artifact. That is, participants were less likely to categorize an item when it was missing a critical feature than when it was missing an unimportant feature. This finding was obtained despite the fact that background knowledge was never explicitly mentioned in the instructions. In addition, this result was replicated using a response deadline procedure (Experiments 4 and 5) and brief stimulus presentations (Experiments 6 and 7). Thus, background knowledge influences category judgments of well-learned concepts even when time constraints are imposed.

Moreover, background knowledge in categorization may also vary as function of expertise (Boster & Johnson, 1989; Medin, Lynch, Coley, & Atran, 1997; Proffitt, Coley, & Medin, 2000). To examine the role of domain-specific knowledge in category-induction tasks, for instance, a set of categories with a given property are used to infer whether another category has that same property. To ensure that an inference is based on categorical reasoning and not on memory retrieval, standard category-induction tasks include novel properties about a given category (e.g., *seismoid bones* as a property for BIRDS). Although prior research suggests that inferences are largely based on similarity and typicality (Rips, 1975), recent evidence suggests that expert knowledge affects reasoning behaviors as well (Medin et al., 1997; Proffitt et al., 2000). To illustrate, Proffitt and colleagues presented tree experts with induction problems about the likelihood of tree susceptibility to disease (e.g., if Disease A affects horse chestnut and Ohio buckeye, and Disease B affects silver maple and amur maple, which disease would be more likely to affect all trees?). They found that tree experts used complex reasoning behaviors (e.g., thickness of bark, ecological setting) to determine which disease would transmit to most trees.

That is, tree experts relied on their background knowledge in making category inferences. Similarity-based reasoning, in contrast, was not found to be a critical determinant in their category-based inferences.

Expert knowledge also influences category-sorting behaviors (Bailenson, Shum, Atran, Medin, Coley, 2002; Medin et al., 1997). For instance, Boster and Johnson (1989) compared sorting behaviors of FISH pictures among expert and novice fishermen. They found that novices based their sorting patterns on perceptual features, in contrast to experts who based their sorting patterns on functional information. In a recent study, Bailenson and colleagues found that bird experts based their category judgments according to a scientific taxonomy in contrast to novices, who based their category judgments on perceptual features. These results are consonant with previous findings that suggest experts and novices differ in terms of the amount and kind of information they possess (Bailenson et al., 2002; Lynch, Coley, & Medin, 2000; Medin et al., 1997). Thus, people tend to sort and categorize objects according to their extant knowledge of a given category.

To summarize, in recent years, researchers have demonstrated the use of theory-based representation in categorization (Murphy & Medin, 1985). That is, prior knowledge affects the ease of category learning (Kaplan & Murphy, 2000; Murphy & Allopenna, 1994) and the categorization of abstract (Hampton, 1981; Kelemen & Bloom, 1994), goal-derived (Barsalou, 1983), and well-learned concepts (Lin & Murphy, 1997). Moreover, theory-based representation accounts for the differential categorization of objects among experts and novices (Boster & Johnson, 1989; Medin et al., 1997; Proffitt et al., 2000). Thus, evidence suggests that prior knowledge influences category representation in a manner that cannot be attributed to similarity-based representation (Medin & Murphy, 1985).

Psychological Essentialism

Psychological essentialism is one type of theory-based categorization. According to this view, people tend to regard objects as having a category "essence," which reflects the underlying nature about a represented object (Gelman, Coley, & Gottfried, 1994; Gelman & Medin, 1993; Keil, 1989; Rips, 1989). An essence serves to constrain and generate an object's apparent properties (Medin & Ortony, 1989). In other words, a belief in essences provides a causal connection between deeper, hidden properties and superficial, observable properties that an object possesses. The essence of a TIGER, for instance, causes it to have *stripes* (Gelman et al., 1994; Gelman & Diesendruck, 1999; Medin & Ortony, 1989). The implication is that category features are not merely correlated; instead, features of an essentialized object are causally represented (Gelman & Hirschfeld, 1999). Psychological essentialism therefore reflects how people's beliefs construe reality; this perspective is in contrast to metaphysical essentialism, which is a philosophical argument of whether essences actually exist in the environment (Gelman, 2004; Gelman & Hirschfeld, 1999). Thus, psychological essentialism refers to the human construction of how people represent objects according to their world beliefs.

Psychological essentialism, however, does not require that people know what an object's essence is (Medin, 1989; Medin & Ortony, 1989). Instead, people may implicitly believe there is an underlying quality responsible for an object's identity, without knowing what constitutes that object's essence. This unknown-yet-believed-in aspect of psychological essentialism is known as an "essence placeholder" (Medin & Ortony, 1989). For instance, people may believe there is a LION essence, although they may not know what constitutes that LION essence. Psychological essentialism posits that people believe in essences despite not being able to identify the content of a category essence. Thus, essentialist beliefs are considered to be a guiding heuristic rather than a detailed theory of beliefs in concept representation (Gelman & Diesendruck, 1999; Keil, 1995; Medin, 1989).

Although it is difficult to assess essentialist beliefs directly (Gelman & Diensendruck, 1999), psychological essentialism may account for the differential categorization of artifacts and natural kinds (Diesendruck & Gelman, 1999; Gelman & Diesendruck, 1999; Gelman & Gottfried, 1996; Keil, 1989; Malt, 1990). Evidence in support of essentialist beliefs in categorization has shown that natural items maintain their category membership despite an apparent transformation (Gelman & Wellman, 1991; Keil, 1989; Rips, 1989). The tendency to maintain category identity upon a type of change suggests that the essence remained intact. To illustrate, Keil presented preschool, second- and fourth-grade children with descriptions about artifactual and natural items that underwent a radical transformation. In one condition, children heard stories about an animal (e.g., raccoon) that underwent an operation to resemble another animal (e.g., skunk). In another condition, the descriptions involved the transformation of artifacts (e.g., a coffee pot made to resemble a bird feeder). Transformations resulted in a category change for artifactual, but not for natural items. That is, the majority of children were more likely judge an artifact as belonging to another category after a transformation. For natural items, however, there was a developmental shift in category judgments. Whereas preschool children were more likely to produce a category change, older children were less likely to change their category response for natural items. In another experiment, Keil also included transformations that involved costume changes (e.g., a lion dressed in a tiger costume). Despite these apparent changes, children recognized that the animal maintained its identity. These findings suggest that animals possess an underlying essence responsible for its category membership, despite perceptual changes. In contrast, artifact transformations resulted in a change in category identity. Thus, categorization of artifactual and natural items may be based on domain differences in essentialist beliefs.

Gelman and Wellman (1991) corroborated this result using a simpler description of transformations. In their study, four- and five-year old children heard descriptions about animals whose ‘insides’ or ‘outsides’ were removed. To illustrate, an *inside removal* reflected the removal of internal properties from an object (i.e., bones and blood removed from a dog), whereas an *outside removal* reflected the removal of external properties from an object (i.e., fur removed from a dog). In both conditions, children were asked whether the identity of the object was preserved after the transformation. Gelman and Wellman predicted that if children were essentialists about animal concepts, then the removal of insides should be more critical than the removal of outsides, which should lead children to produce an identity change for the animal whose insides had been removed. In support of their prediction, the majority of children reported that the removal of insides, but not the removal of outsides, changed a creature’s identity. Thus, Gelman and Wellman concluded that children rely on internal properties in making category judgments.

To be sure, however, explanations for the domain difference of artifactual and natural kinds vary (Atran, 1998; Bloom, 1998; Diesendruck & Gelman, 1999; Gelman & Hirschfeld, 1999; Keil, 1989). A belief in category essences may be absolute (Diesendruck & Gelman, 1999); or, a belief in category essences may be graded (Gelman & Hirschfeld, 1999). Some argue that natural kinds have essences but artifacts do not (Atran, 1998; Diesendruck & Gelman, 1999; Keil, 1989). Others claim that both artifacts and natural kinds have qualitatively different essences; natural kinds have a biological essence, whereas artifacts have a functional essence (Bloom, 1998; Putnam, 1975). Nonetheless, despite these varying models of psychological essentialism, domain differences in the categorization of artifacts and natural kinds may be attributable to the general belief that objects posses an underlying essence, which determines its category membership.

Domain Difference in Beliefs

Deference to experts is one way to infer people's beliefs about artifactual and natural categories. For instance, if an individual is uncertain about an object's classification, she may defer to the judgment of an expert. Putnam (1975) referred to this as the "linguistic division of labor," which states that knowledge is divided amongst members of a linguistic community. Each individual, therefore, need not know the meaning of every word in the language. Rather, certain linguistic categories are known only by a subset of the population, and individuals may defer to those experts for identifying uncertain category members (e.g., *gold*). Some categories (e.g., CHAIR), however, may not be subject to the linguistic division of labor. As Malt (1990) has empirically shown, deference to experts is greater for natural categories than artifactual categories. For instance, the sentence "According to experts, a *tomato* is a FRUIT" is judged more acceptable than the sentence "According to experts, a *fork* is a WEAPON." Note that in this paradigm, deference to experts implies there is a correct classification, and that the naïve individual's opinion is irrelevant to that classification.

Similarly, the dispute resolution paradigm is another implicit method to determine people's beliefs about artifactual and natural categories. In this paradigm, a scenario is presented in which two individuals disagree about the category of an object. The task is to decide whether one of the disputants must be wrong, or whether it is legitimate to disagree. For example, suppose that John and Jane disagree about whether a *tomato* is a FRUIT. When natural categories (e.g., FRUIT) are disputed, participants tend to judge that one of the disputants must be wrong; the object either is or is not a fruit. In contrast, when artifactual categories (e.g., WEAPON) are disputed, participants tend to judge that the disagreement is legitimate (Kalish, 1995, 2002; Malt, 1990). These judgments imply a domain difference in belief: For natural categories, the "correct" classification implies a belief in category objectivity. For artifact categories, however, the legitimacy to disagree implies a belief in category subjectivity.

In a recent study, Kalish (2002) used ambiguous items presented in scenarios (e.g., a plant "sort of halfway between a marigold and a dandelion") involving an expert panel that must decide whether it belonged to one target category (i.e., MARIGOLD) or another (i.e., DANDELION). Artifactual and natural items were presented, and participants rated the degree to which experts should resolve the classification issue by scientific investigation or by legislation. A preference for scientific investigation indicates an objectivist belief because it implies that the object has one discoverable category, whereas a preference for legislation indicates a subjectivist belief because it implies that the object is classified by convention or opinion. Kalish found that preference for classification by scientific investigation was above chance for natural items, but not for artifacts. In contrast, preference for classification via legislation was above chance for artifacts, but not for natural items. Thus, using ambiguous items, Kalish (2002) replicated the domain difference in beliefs about category subjectivity previously obtained by Malt (1990) and Kalish (1995).

Hampton (1998) corroborated this result using a technical-categorization task. In that experiment, participants made category judgments on the basis of whether a concept "technically" belonged to a category. The hedge "technically speaking" implies that a concept is an atypical category member, although it satisfies the definitional criteria of the category (Lakoff, 1987). Therefore, technical categorization is analogous to the "according to experts" hedge because it implies an objectively correct answer (Malt, 1990). Hampton found that technical categorization accounted for a significant amount of variance in natural and biological category judgments but not in artifactual category judgments.

Domain Difference in Categorization

Consistent with domain differences in the beliefs of artifacts and natural objects, membership in a given category may be absolute or graded. If category membership is absolute, then an object either is or is not a member of the category, and category members share an equal membership status. For instance, a *tomato* is just as much of a full member of the category FRUIT as an *apple*. If, however, category membership is graded, then an object may belong to the category, but to a lesser extent, and category members may have an unequal membership status. For instance, a *rug* may be a partial member of the category FURNITURE, which means it is less of a member than a *chair* (Rosch, 1978). In this regard, the category structure for artifacts is more graded than for natural objects, which is more absolute (e.g., Diesendruck & Gelman, 1999; Estes, 2003).

Early research on category structure confounded typicality and category membership (e.g., Rosch, 1978; Rosch & Mervis, 1975). In many cases, typicality was an index of category membership. For instance, prior research found typical items (e.g., *robin*) to be categorized more consistently than atypical items (e.g., *penguin*; McCloskey & Glucksberg, 1978). In addition, typical items are faster to categorize than atypical items in verification tasks (Rips, Shoben, & Smith, 1973). Based on these results, previous research found these typicality effects to be indicative of category membership.

Recent research, however, has clarified whether semantic categories have an absolute or graded structure while controlling for typicality (Barr & Caplan, 1987; Diesendruck & Gelman, 1999; Estes, 2003; Kalish, 1995). To test for gradedness, Barr and Caplan used a 7-point scale; intermediate values were assumed to reflect a graded category structure, and scalar endpoints were assumed to reflect an absolute category structure. Thus, responses from 2 to 6 were considered to reflect partial membership. Barr and Caplan found that several semantic categories contained a graded category structure, although domain differences between artifactual and natural categories were not examined.

Kalish (1995) directly tested for domain differences in the category structure of artifactual and natural kinds. Using the same scalar method as Barr and Caplan (1987), Kalish did not obtain a domain difference in the gradedness of artifactual and natural categories and concluded that both domains exhibit a graded category structure. This result, however, may be due to inadequate sampling of items as only 20 items were used (10 artifacts, 10 natural items). Using a larger set of items, Diesendruck and Gelman (1999) used the same scalar method and found artifactual categories received more graded responses than natural categories, suggestive of a domain difference in category structure.

To amend this conflicting evidence, Estes (2003) measured gradedness directly using a three-alternative forced-choice method (i.e., “full member,” “partial member,” and “nonmember”). Definite category members (e.g., *apple*--FRUIT) and clear nonmember items (e.g., *carrot*-- FRUIT) were sampled. In addition, borderline items (e.g., *tomato*-- FRUIT) were included because they were most likely to receive partial membership responses. In corroboration of Diesendruck and Gelman’s (1999) findings, artifacts were found to receive more partial membership responses than natural items, which suggest that artifactual categories are indeed more graded than natural categories. Moreover, this effect was replicated using a novel paradigm (Experiment 3). Thus, domain differences in category structure suggest artifacts tend to be categorized as a matter of degree, whereas natural items are categorized in an absolute manner.

In summary, then, there are clear domain differences in beliefs about artifactual and natural categories, as well as in the gradedness of artifactual and natural categories. Specifically, artifactual categories are perceived to be more subjective and more graded than natural categories. So given that beliefs are presumed to affect categorization (Murphy & Medin, 1985), the domain difference in belief may in fact causally explain the domain difference in gradedness. Surprisingly, a causal relation between category beliefs and category gradedness has yet to be established. Thus, the purpose of this investigation is to examine whether individual's beliefs do indeed explain their categorization behavior. If perceived subjectivity determines gradedness, then increased subjectivity should result in graded category structure, whereas decreased subjectivity should result in absolute category structure. To test this hypothesis, two studies established a relation between perceived subjectivity and gradedness, and two experiments tested the potential causal relation between perceived subjectivity and gradedness.

CHAPTER 2

STUDY 1: ESTABLISHING A RELATION OF PERCEIVED SUBJECITIVITY AND GRADEDNESS

Because borderline items (e.g., *tomato*) are at the cusp of belonging in a given category (e.g., FRUIT), responses to those items are most likely to exhibit a graded membership. Gradedness may be influenced by one's epistemological beliefs of category structure (Estes, 2004; Kalish, 1995; 2002). To test this hypothesis, the following study was conducted to determine whether perceived subjectivity predicts a graded category structure. One group of participants judged the category membership of 164 borderline items (artifactual and natural), and an independent group judged whether the category membership of those items was subjective or objective. A third independent group also rated the typicality of these items, so as to control for that potentially confounding variable.

Method

Participants

One hundred and seven undergraduates participated in the study for partial course credit. Participants were randomly assigned to three conditions: 38 participants reported perceived subjectivity, 38 participants rated item typicality, and 31 participants provided category judgments.

Materials

Borderline items were sampled from previous investigations on category structure (Barr & Caplan, 1987; McCloskey & Glucksberg, 1978). Seventeen categories were used: 10 natural categories and 7 artifactual categories. Items taken from Barr and Caplan had a mean membership rating between 3.01 and 5.00 on a 1 (clear nonmember) to 7 (clear member) scale. Items from McCloskey and Glucksberg were selected on the basis of disagreement about an item's category membership (e.g., non-modal response). Items with a mean probability of disagreement ranging from .30 to .50 were selected for the current study. In other words, 30% to 50% of participants disagreed with the modal category response to that item. Note that this range captures items that received the most disagreement (i.e., the nonmodal response could not exceed .50). Based on the set of items, ambiguous items (e.g., Big Bird) and repetitions were excluded to yield 164 borderline items (82 artifacts and 82 natural items) in the current study. See Appendix A for a complete list of stimuli.

Procedure and Measures

A category statement was created for each of the 164 borderline items (e.g., A lobster is a fish). Participants were randomly assigned to one of three conditions; within each condition, participants responded to each borderline item. Item order was randomized with each experimental condition and participants' responses were self-paced.

Typicality Ratings. Participants rated the typicality of a concept (e.g., billiards) in a given category (e.g., sport) on a scale from 1 (not at all typical) to 7 (very typical).

Category Judgments. Based on a procedural replication from Estes (2003), a three-alternative forced-choice method (1=clear nonmember, 2=partial member, 3=full member) was used, and participants were informed of the meaning of partial membership using *billiards* as an example:

If you believe billiards is not a sport, then you should select the "nonmember"

> option. Or, if you think that billiards is only somewhat a member of the category, then you should select the "partial member" option. But if you believe that it's just as much a member of the category as any other sport, then you should indicate that it's completely a member by selecting the "full member" option…Partial membership means that the item does belong in the category, but not to the same extent as some other items.

The proportion of partial membership responses served as the dependent variable in the analysis because those judgments best reflect a graded category structure.

Subjectivity Judgments. Participants indicated whether each statement was objective or subjective. Instructions emphasized the general difference between objectivity and subjectivity with the following statement: "if a question is objective, then its answer must be either definitely true or definitely false. In contrast, if a question is subjective, then it doesn't necessarily have a right or wrong answer--it is more a matter of one's own personal opinion." Participants were instructed to select one response (i.e., objective, subjective) for each statement.

Results

All data were submitted to two sets of analyses, one with participants (t_p) and another with items (t_i) as a random factor. Three outlying items (i.e., *rhinestone* – PRECIOUS STONE, *bureau*—FURNITURE , and *sledge hammer*—TOOL) were removed from the analysis because their mean for typicality, subjectivity, or gradedness was 2.5 standard deviations beyond the group mean.

Typicality. Typicality ratings of borderline items in the artifact (M = 4.01, SE = .10) and natural (M= 3.92, SE = .12) categories were not significantly different, t_p (37) = 1.04, p = .31 and t_i (159) < 1. That is, no domain difference in typicality was obtained for artifactual and natural categories. This control is important because previous research confounded typicality and category membership (e.g., Rosch & Mervis, 1975). Despite this lack of a domain difference in typicality, however, typicality ratings negatively predicted category gradedness [$r^2 = -.15$, $p = .06$] and perceived subjectivity responses [$r^2 = -.20$, $p = .01$]. Therefore, subsequent item analyses involving partial membership and subjectivity responses used an analysis of covariance (ANCOVA) to remove typicality as a potential confounding variable.

Category gradedness. The proportion of partial member responses was the dependent measure. As evident in Figure 1, artifactual items ($M_{adj} = .41$, $SE_{adj} = .02$) were more likely to receive a partial membership response than natural items ($M_{adj} = .29$, $SE_{adj} = .01$), $t_p (30) = 4.51$, $p < .0001$, and $F_i (1, 158) = 35.45$, $p < .0001$. This result replicates prior findings of domain differences in the gradedness of artifactual and natural categories (Diesendruck & Gelman, 1999; Estes, 2003).

Subjectivity. The proportion of subjective responses served as the dependent measure. Figure 2 shows that artifactual items ($M_{adj} = .64$, $SE_{adj} = .02$) were judged with greater subjectivity than natural items ($M_{adj} = .30$, $SE_{adj} = .01$), $t_p (37) = 7.69$, $p < .0001$ and $F_i (1, 158) = 251.97$, $p < .0001$.

Subjectivity and Gradedness. A correlation between the proportion of partial membership responses and the proportion of subjective responses was calculated across items. As shown in Figure 3, perceived subjectivity and gradedness were positively correlated across the artifactual and natural domain**,** $r (160) = .51$, $p < .01$. This result establishes a relation between perceived subjectivity and gradedness, which also supports prior findings of domain difference in the category structure of artifacts and natural items (Diesendruck & Gelman, 1999; Estes, 2003). Correlations between perceived subjectivity and gradedness were also calculated within the artifactual and natural domains. A positive relation obtained within the artifactual domain, $r(81) = .53$, $p < .0001$ but not in the natural domain, $r(81) = .16$, $p < .31$. This result suggests that an increase in perceived subjectivity corresponds with an increase in gradedness. The lack of finding a positive relation of perceived subjectivity and gradedness within the natural domain, however, may be due to measurement error. This issue is addressed in Study 2.

Discussion

The domain difference in gradedness replicates previous results (Diesendruck & Gelman, 1999; Estes, 2003), and the domain difference in perceived subjectivity also corroborates previous findings (Kalish, 1995, 2002; Malt, 1990). The question of current interest is whether the latter finding can explain the former, as theory-based models of categorization would predict. And in fact, the significant positive correlation suggests that perceived subjectivity does indeed predict category gradedness, thus indicating that the causal hypothesis is plausible.

CHAPTER 3

STUDY 2: INDIVIDUAL DIFFERENCES IN PERCEIVED SUBJECTIVITY AND GRADEDNESS

Results from Study 1 suggest that the domain difference in perceived subjectivity predicts the domain difference in gradedness. Artifactual category statements (e.g., "A rug is a type of furniture.") received more subjective judgments than natural category statements (e.g., "A tomato is a fruit."). In addition, a positive relation was obtained between perceived subjectivity and gradedness. Therefore, perceived subjectivity may underlie a graded category structure.

Notice the positive relation of perceived subjectivity and gradedness was established across items because different groups of participants provided category and subjective responses. Therefore, it is unknown whether individual differences in perceived subjectivity influence one's category behavior. That is, a person may be more (or less) inclined to perceive objects in a subjective manner. Consequently, one's perceived subjectivity of artifactual and natural categories may determine whether items are classified in an absolute or graded manner. Given a positive relation of perceived subjectivity and gradedness obtained in Study 1, individual differences in perceived subjectivity may also account for domain differences in category structure. Therefore, the purpose of Study 2 was to examine whether perceived subjectivity predicts gradedness within-participants. In this study, participants categorized artifactual and natural items and rated their perceived subjectivity of each item. If categorization is based on belief, perceived subjectivity should determine the gradedness of artifactual and natural items. Specifically, if one believes that knowledge of a given category is objective, then she should categorize borderline items absolutely. And if one believes that knowledge is subjective, she should be more likely to categorize borderline items in a graded manner.

Method

Materials

Materials are identical to that of Study 1.

Procedure

Thirty-three undergraduates participated for partial course credit. Using the three alternative forced-choice method from Study 1, participants classified 164 borderline items. After each category judgment, participants rated their perceived subjectivity of artifacts and natural kinds using a 1 (not at all subjective) to 7 (very subjective) scale. The scalar method was used in the current study because it is generally considered a more sensitive measure than the dichotomous method used in Study 1. Item order was randomized and participants' responses were self-paced.

Results

The proportion of partial membership responses and mean subjective ratings were the dependent variables in the analyses. As in Study 1, three outliers were removed prior to analyses because their mean typicality exceeded 2.5 standard deviations from the group mean (recall that typicality was a covariate in the item analysis).

As shown in Figure 4, artifact categories (M_{adj} = .53, SE_{adj} = .01) received greater partial membership responses than natural items (M_{adj} = .32, SE = .01), F_p (1, 31) = 34.55, p < .0001, and F_i (1,158) = 117.49, p < .0001. In addition, Figure 5 indicates that artifact categories (M_{adj} = 3.93, SE_{adj} = .05) were rated more subjective than natural categories (M_{adj} = 3.02, SE_{adj} = .05), F_p (1, 31) = 20.13, p < .0001, and F_i (1,158) = 141.03, p < .0001. These results replicate findings from Study 1 and previous investigations of category structure and perceived subjectivity (Diesendruck & Gelman, 1999; Estes, 2003; Kalish, 1995, 2002; Malt, 1990).

Subjectivity and Gradedness. Correlations between partial membership responses and mean subjectivity ratings were calculated across items. Figure 6 indicates that perceived subjectivity and gradedness were positively correlated across domains [$r(160) = .87$, $p < .0001$]. This positive relation also obtained within the artifactual [$r(79) = .76$, $p < .0001$] and natural domain [$r(80) = .77$, $p < .0001$]. Results in the current study replicate findings from Study 1 in establishing a positive relation of perceived subjectivity and gradedness.

Individual Differences in Subjectivity and Gradedness. Correlations between partial membership responses and mean subjectivity ratings were also calculated across participants. As shown in Figure 7, perceived subjectivity and gradedness were positively correlated, [$r(32) = .73$, $p < .0001$]. Moreover, Figures 8 and 9, respectively indicate a positive relation of perceived subjectivity and gradedness within the artifactual [$r(32) = .67$, $p < .001$] and natural domain [$r(32) = .67$, $p < .0001$]. These findings support the prediction of individual differences in the perceived subjectivity of borderline artifactual and natural items.

Discussion

These results replicate domain differences in gradedness and perceived subjectivity obtained in Study 1. That is, artifacts were judged more graded than natural items; and using the scalar method, artifacts were rated more subjectively than natural items. Moreover, a strong positive relation was found between perceived subjectivity and gradedness within category domains, presumably because the same participant provided both category judgments and subjectivity ratings for each item. This result supports the notion of individual differences in perceived subjectivity, which may in turn, account for differences in graded category structure.

In sum, the positive relation between perceived subjectivity and gradedness supports the prediction that epistemic beliefs influence the categorization of artifacts and natural items. Findings from this study suggest differences in gradedness may correspond to individual differences in perceived subjectivity. In other words, a domain difference in categorization may be attributable to a domain difference in beliefs: whereas a belief in objectivity is consonant with absolute category judgments, a belief in subjectivity is consonant with graded category judgments. Thus, results from this study establish a stronger relation between epistemic beliefs and category structure.

CHAPTER 4

EXPERIMENT 1: MANIPULATION OF PERCEIVED SUBJECTIVITY ON GRADEDNESS USING A RANDOM PRESENTATION METHOD

Given the results from Studies 1 and 2, the purpose of Experiment 1 was to investigate a potential causal relation of perceived subjectivity and gradedness. If beliefs causally affect categorization behavior, then gradedness should be influenced by the perceived subjectivity of artifactual and natural items. To manipulate perceived subjectivity, filler items served as a contextual variable in two conditions. In the standard condition, filler items consisted of subjective artifacts and objective natural items. In the reversed condition, filler items consisted of objective artifacts and subjective natural items. Across both conditions, critical items were artifactual and natural items of intermediate subjectivity. It is unknown whether categorizing the contextual variable would produce contrast or assimilative effects. If a contrast effect obtains in the standard condition, filler items should produce decreased partial membership responses for critical artifactual items and increased partial membership responses for critical natural items. Similarly, if a contrast effect obtains in the reversed condition, filler items should produce increased partial membership responses for critical artifactual items and decreased partial membership responses for critical natural items. The inverse pattern of results would obtain, however, if assimilation were to occur. That is, if assimilation were to obtain in the standard condition, filler items should produce increased partial membership responses for critical artifactual items and decreased partial membership responses for critical natural items. If assimilation were to obtain in the reversed condition, filler items should produce decreased partial membership responses for critical artifactual items and increased partial membership responses for critical natural items. Notice that a contrast or assimilative effect should produce a significant interaction if perceived subjectivity influences gradedness of critical artifactual and natural items.

Method

Materials and Design

Mean subjectivity ratings from Study 2 were sorted within each category domain to select filler items for Experiment 1. Based on this assortment, 20 subjective (Artifacts: M = 4.42, SE = .09; Natural: M = 3.60, SE = .07) and 20 objective (Artifacts: M = 2.67, SE = .04; Natural: M = 2.20, SE = .02) filler items were selected from list endpoints. Because domain differences in perceived subjectivity obtained in Study 2, critical items were sampled from the midpoint of each list in order to minimize differences in perceived subjectivity. Therefore, critical items included 10 artifactual (M = 3.55, SE = .01) and 10 natural (M = 2.91, SE = .04) items of intermediate subjectivity.

Filler items were arranged into two conditions: In the standard condition, filler items were subjective artifacts and objective natural items. In the reversed condition, filler items were objective artifacts and subjective natural items. Critical artifactual and natural items were identical across both conditions. Participants were randomly assigned to standard and reversed conditions. Hence, a 2 (Condition: standard, reversed; between-participants) by 2 (Category domain: artifactual, natural; within-participants) mixed-participant design was used in the current experiment.

Pretest. As a manipulation check, 76 participants were randomly assigned to the contextual conditions. Participants in this pre-test were asked to rate their perceived subjectivity of artifactual and natural items on a 1 (not at all subjective) to 7 (very subjective) scale. This procedure was used to ensure that the contextual variable influenced perceived subjectivity ratings. Mean subjectivity ratings for critical artifactual and natural items were submitted to a 2 (Domain: artifactual, natural; within-participants) x 2 (Condition: standard, reversed; between-participants) mixed-participant ANOVA. As shown in Figure 10, the domain by condition interaction was significant, F_p (1, 74) = 6.41, p = .01 and F_i (1, 18) = 15.84, p < .001. The main effect of domain was also reliable, F_p (1, 74) = 16.01, p < .0001 and F_i (1, 18) = 24.99, p < .001. In addition, mean subjectivity ratings of filler items were submitted to a 2 (Domain: artifactual, natural) x 2 (Condition: standard, reversed) between-participants ANOVA. A crossover interaction obtained, F_p (1, 74) = 39.57, p < .0001 and F_i (1, 36) = 67.69, p < .0001. As shown in Figure 11, artifacts were rated more subjective in the standard than in the reversed condition, whereas natural items were rated more subjective in the reversed than in the standard condition. No other effects were reliable, all p > .10. These findings verify that the contextual manipulation influences perceived subjectivity ratings of critical artifactual and natural items.

Procedure

As in Studies 1 and 2, the current experiment used a three alternative-forced choice category-judgment task. Across conditions, participants categorized 40 artifactual and natural items (i.e., 20 filler and 20 critical items). Items were randomly presented and participants' responses were self-paced. Sixty-five undergraduates participated for partial course credit.

Results

Data were submitted to a 2 (Condition: standard, reversed; between-participants) x 2 (Domain: artifactual, natural; within-participants) mixed-participants ANCOVA. Filler items were analyzed separately from critical items and were submitted to a 2 (Domain: artifactual, natural) x 2 (Condition: standard, reversed) between-participants ANCOVA.

Critical items. Figure 12 illustrates the proportion of partial membership responses to critical artifactual and natural items. The main effect of domain was reliable, F_p (1, 63) = 28.11, $p < .0001$ and F_i (1, 17) = 23.51, $p < .0001$. Artifactual items (M_{adj} = .49, SE_{adj} = .04) received greater partial membership responses than natural items (M_{adj} = .29, SE_{adj} = .03). The main effect of condition was not statistically significant, F_p (1, 63) < 1 and F_i (1, 18) = 2.12, p = .16. Nor was the domain by condition interaction significant, F_p (1, 63) < 1 and F_i (1, 18) = 1.61, p = .22. This result indicates that perceived subjectivity did not influence gradedness across the standard and reversed conditions.

Filler items. As shown in Figure 13, the main effect of domain was reliable, F_p (1, 63) = 21.56, $p < .0001$ and F_i (1, 35) = 8.92, $p < .005$. Artifacts (M_{adj} = .42, SE_{adj} = .04) received greater partial membership responses than natural items (M_{adj} = .30, SE_{adj} = .03). The main effect of condition was not reliable, both F < 1. The domain by condition interaction obtained, F_p (1, 63) = 61.53, $p < .0001$ and F_i (1, 35) = 30.59, $p < .0001$. Artifacts in the standard condition (M_{adj} = .56, SE_{adj} = .04) received greater partial membership responses than artifacts in the reversed condition (M_{adj} = .29, SE_{adj} = .05). Natural items in the reversed condition (M_{adj} = .39, SE_{adj} = .04) received greater partial membership responses than natural items in the standard condition (M_{adj} = .20, SE_{adj} = .03). These results indicate a domain difference in category structure and an assimilative effect in the categorization of filler items based on domain differences in perceived subjectivity.

Discussion

Results from the current study replicate prior findings of a domain difference in gradedness (e.g., Diesendruck & Gelman, 1999; Estes, 2003). However, the contextual manipulation of perceived subjectivity did not influence the gradedness of critical artifacts and natural items of intermediate subjectivity. Failure to obtain a significant interaction may be attributable to the random presentation of critical and filler items. That is, random presentation of items may not have sufficiently influenced the gradedness of artifactual and natural items. Therefore, Experiment 2 was designed to test whether perceived subjectivity influences category behavior when filler items are presented prior to critical items.

CHAPTER 5

EXPERIMENT 2: MANIPULATION OF PERCEIVED SUBJECTIVITY ON GRADEDNESS USING A BLOCKED PRESENTATION METHOD

The purpose of Experiment 2 was to re-examine whether a causal relation between perceived subjectivity and gradedness would obtain using a blocked method. If perceived subjectivity influences category behavior, this method may produce contrast or assimilative effects in categorization (see Chapter 4 for a description of contrast and assimilative effects).

Method

Materials and Design

Materials were identical to that of Experiment 1. Instead of randomly presenting items, however, a blocked method was used to present filler items prior to critical items within each category domain. As in Experiment 1, perceived subjectivity was manipulated between-participants in two conditions and category domain was manipulated within-participants. The blocking factor was counterbalanced across category domains.

Procedure

The procedure was slightly modified from Experiment 1. In this experiment, the same participants rated their perceived subjectivity of artifactual and natural items on a 1 (not at all subjective) to 7 (very subjective) scale and provided category judgments using a three-alternative forced-choice method. Eighty undergraduates were randomly assigned to experimental conditions.

Results

Mean subjective ratings and proportion of partial membership responses served as the dependent measures in this experiment. Filler items were analyzed separately from critical items in the following analyses. Mean subjective ratings were submitted to a 2 (Domain: artifactual, natural; within-participants) x 2 (Condition: standard, reversed; between-participants) mixed-participants ANOVA. Partial membership responses were submitted to a 2 (Domain: artifactual, natural; between-participants) x 2 (Condition: standard, reversed; within-participants) mixed-participants ANCOVA.

Subjectivity ratings. As shown in Figure 14, mean subjective ratings for critical items did not yield a domain by condition interaction, both $F < 1$. In addition, the main effects of domain and condition were not significant, all $p > .20$. For filler items (Figure 15), the domain by condition interaction did not obtain in the participant analysis, F_p (1, 78) = 1.73, $p = .19$, but was reliable in the item analysis, F_i (1, 36) = 35.15, $p < .0001$. The main effect of domain was also reliable in the item analysis, $F_p < 1$ and F_i (1, 36) = 16.85, $p < .0001$. The main effect of condition was not significant, both $p > .10$. Results from these analyses indicate that the contextual manipulation did not reliably influence perceived subjectivity across conditions.

Gradedness of Critical items. The proportion of partial membership responses for critical items is shown in Figure 16. The main effect of domain was reliable, F_p (1,78) = 70.07, $p < .0001$ and F_i (1,17) = 35.48, $p < .0001$. Artifacts ($M_{adj} = .52$, $SE_{adj} = .03$) were judged more graded than natural items ($M_{adj} = .28$, $SE_{adj} = .04$). The main effect of condition, however, was not reliable, $F_p < 1$ and F_i (1,18) = 1.07, $p = .32$. Nor was the domain by condition interaction statistically significant, F_p (1, 78) = 1.37, $p = .25$ and F_i (1, 18) = 2.69, $p = .12$. These results indicate that perceived subjectivity across the standard and reversed conditions did not influence the gradedness of critical artifactual and natural items.

Gradedness of Filler items. The proportion of partial membership responses for filler items is shown in Figure 17. The main effect of domain was significant, F_p (1, 78) = 12.15, p < .0001 and F_i (1, 35) = 8.18, p < .05 such that artifacts (M_{adj} = .44, SE_{adj} = .04) were more graded than natural (M_{adj} = .32, SE_{adj} = .03) items. The main effect of condition was not reliable, F_p (1, 78) = 1.58, p = .21 and F_i (1, 35) = 1.68, p = .20. The domain by condition interaction obtained, F_p (1, 78) = 49.15, p < .0001 and F_i (1, 35) = 29.51, p < .0001. Artifacts received greater partial membership responses in the standard (M_{adj} = .57, SE_{adj} = .04) than in the reversed (M_{adj} = .30, SE_{adj} = .05) condition. Natural items, however, received greater partial membership responses in the reversed (M_{adj} = .40, SE_{adj} = .04) than in the standard (M_{adj} = .23, SE_{adj} = .03) condition. This result indicates filler items differed as a function of perceived subjectivity across conditions.

Discussion

Results from this experiment replicate the domain difference in gradedness found in prior investigations on category structure (Diesendruck & Gelman, 1999; Estes, 2003). However, using a blocked design did not elicit differences in category structure as a function of perceived subjectivity. This blocking factor may not have been a strong manipulation to produce differences in category gradedness. Moreover, from a general perspective, the number of critical items may not have been sufficient to detect differences in gradedness in Experiments 1 and 2. These plausible explanations are considered in the general discussion.

CHAPTER 6

GENERAL DISCUSSION

The purpose of this investigation was twofold: (1) to determine whether domain differences in perceived subjectivity predict domain differences in gradedness; and (2) to examine the potential causal relation of perceived subjectivity and category gradedness. Evidence from two studies established a positive relation between perceived subjectivity and category gradedness: artifacts were perceived more subjective and more graded than natural items. The positive correlation obtained across and within category domains using different samples of participants (Study 1). In addition, these findings replicated when individual differences in perceived subjectivity were considered (Study 2).

Moreover, finding a positive relation of perceived subjectivity and gradedness yielded a novel hypothesis: whereas increased subjectivity produces graded category responses, decreased subjectivity produces absolute category responses. Results from two experiments, however, did not support a causal relation between perceived subjectivity and gradedness. In fact, perceived subjectivity had little effect on category gradedness when items were randomly presented (Experiment 1) or presented in a blocked format (Experiment 2). These findings have theoretical and empirical implications for domain differences in beliefs and gradedness of artifactual and natural concepts, as described below.

Positive Relation of Perceived Subjectivity and Gradedness

From a theoretical perspective, domain differences in perceived subjectivity and gradedness are not readily supported by similarity-based representation in categorization. In this investigation, artifacts and natural items were matched on typicality and statistically controlled. According to Resemblance theory (e.g., Medin & Shaffer, 1978; Nosofsky, 1988; Rosch, 1975), typicality effects predict category membership. That is, domain differences in typicality influence domain differences in category structure. Removal of typicality should therefore eliminate domain differences in category gradedness. Findings from two studies, however, revealed domain differences in beliefs and category structure despite controlling for typicality: increased perceived subjectivity and gradedness were positively related. Thus, similarity-based representation does not account for the positive relation of perceived subjectivity and gradedness.

Theory-based representation, however, offers an alternative explanation for the results obtained in these studies. According to this view, categorization is inference to the best explanation with respect to one's world beliefs (Murphy & Medin, 1985). Essentialist beliefs, for instance, account for domain differences in gradedness (Estes, 2003). Whereas artifacts are believed to be subjectively decided, natural items are construed to be objectively determined (Kalish, 1995, Estes, 2004; Malt, 1990). Moreover, results from this investigation suggest domain differences in perceived subjectivity correspond to domain differences in gradedness. That is, gradedness is a contingent on whether category members are perceived to be a matter of fact or a matter of opinion. Individuals in favor of a subjectivist perspective are more likely to categorize in a graded manner. Conversely, individuals who adopt an objectivist perspective are more likely to categorize absolutely.

From an empirical perspective, the establishment of a positive relation of perceived subjectivity and gradedness corroborates prior research on confidence and gradedness (Estes, 2004). In that study, artifactual items were judged with greater confidence and were more graded than natural items. Taken together, results from Estes (2004) and from the current investigation suggest confidence and perceived subjectivity influence category structure in a concerted manner. Because artifacts are subjectively decided (i.e., a matter of opinion), people are more confident in their category judgments and more likely to provide a graded category judgment. In contrast, because natural items are objectively determined (i.e., a matter of fact), people are less confident in their category judgments and more likely to provide an absolute category judgment. Therefore, the domain difference in perceived subjectivity corresponds to the domain difference in confidence.

The domain difference in perceived subjectivity is also consonant with dispute resolution paradigms as a measure of category subjectivity (Kalish, 1995, 2002; Malt, 1990). In those studies, artifact categories were found to be subjectively determined by convention, whereas natural categories were objectively decided by scientific investigation. The current study expands those findings by establishing the relation between perceived subjectivity and category structure. In this case, beliefs of objectivity are analogous to scientific investigation, which reflect absolute category judgments whereas beliefs of subjectivity are analogous to convention, which reflect graded category judgments.

Causal Relation of Perceived Subjectivity and Gradedness

Two experiments tested whether perceived subjectivity influences domain differences in category structure. Perceived subjectivity was manipulated as a contextual variable using items considered to be objective or subjective. These items were predicted to influence the gradedness of items of intermediate subjectivity. Despite the orthogonal manipulation of perceived subjectivity, however, artifacts were more graded than natural items. This finding replicates prior findings of a domain difference in category structure (Diesendruck & Gelman, 1999; Estes, 2003; Hampton, 1998), and suggests that the domain difference in category structure is robust (cf., Kalish, 1995). That is, category responses changed relatively little as a function of perceived subjectivity. These results suggest a default categorization scheme for artifacts and natural items such that artifacts are more graded than natural kinds (see Hampton, Dubois, & Yeh, unpublished manuscript, for a similar argument). That is, individuals rely on similar conceptual representations despite changes in perceived subjectivity of artifactual and natural categories.

Although the present experiments do not establish a causal relationship between essentialist beliefs and category structure, psychological essentialism may provide insight for lack of observing changes in gradedness as a function of perceived subjectivity. Because essences are invariant properties of an object (Medin & Ortony, 1989), apparent changes must reflect a change in category essence in order to affect category membership (Keil, 1989; Gellman, 2004; Gellman & Wellman, 1991; Rips, 1989). According to this theory, natural categories may possess a biological essence whereas artifactual categories exhibit a functional essence (Bloom, 1998; Gelman & Hirschfeld, 1999; Gellman & Wellman, 1991; Keil, 1989); in contrast, essentialist beliefs may correspond to natural categories only (Atran, 1998; Diesendruck & Gelman, 1999). Therefore, perceived subjectivity should influence category membership if domain differences in perceived subjectivity reflect an essentialist belief in categorization. Perceived subjectivity, however, did not influence domain differences in category structure (Experiments 1 and 2), despite a positive relation between perceived subjectivity and category gradedness (Studies 1 and 2). One interpretation is that perceived subjectivity is not essential in category structure, as evident in two experiments. Alternatively, beliefs of subjectivity may be attributable to individual differences in perceived subjectivity and are unlikely to change across contexts (Study 2). Thus, results from this investigation do not provide conclusive evidence of whether perceived subjectivity is an essentialist belief in categorization.

Empirical limitations may provide a clearer explanation for lack of finding a causal relation of perceived subjectivity and category gradedness. One issue may be due to sampling of experimental items. That is, a restricted number of critical items may have been insufficient to detect difference in gradedness. In addition, experimental items consisted of borderline concepts, which are more graded than clear members and full nonmembers (Barr & Caplan, 1987; McCloskey & Glucksberg, 1978, Rosch, 1978). Clear members, in contrast, are likely to exhibit greater perceived objectivity and absolute category judgments than borderline items. Therefore, use of clear members in Experiments 1 and 2 in conjunction with borderline items would increase the number of experimental items and maximize differences in perceived subjectivity across conditions. In turn, differences in perceived subjectivity may influence category structure. This manipulation remains for future research.

Another point to consider is that the finding a positive relation does not necessarily imply a causal relation between perceived subjectivity and gradedness. In this investigation, it was assumed that perceived subjectivity influenced category gradedness. The direction of this relation, however, may be reversed. That is, graded category responses may result in increased perceived subjectivity and absolute category responses may result in increased perceived objectivity. Alternatively, the positive relation may be due to another variable. In this case, the positive relation of perceived subjectivity and gradedness may be explained by the role of background knowledge on category structure. Prior evidence suggests that people defer to experts when they are uncertain of category membership (Kalish, 1995, 2002; Malt, 1990; Putnam, 1975). Domain knowledge in natural categories, for instance, may therefore influence one's perceived subjectivity and category structure. Of course, these possibilities remain for future research on perceived subjectivity and gradedness of artifactual and natural categories.

Context Effects in Categorization

Because differences in category structure were not obtained as a function of perceived subjectivity in two experiments, it seems reasonable to conclude that category behavior is not susceptible to contextual manipulation. Context effects in categorization, however, have been demonstrated using situational factors (Barsalou, 1987; Barsalou & Sewell, 1984; Roth & Shoben, 1983). For instance, Barsalou and Sewell found that asking participants to adopt the point of view of a housewife or redneck changed their typicality judgments. In addition, changes in sentential contexts influence category gradedness. Roth and Shoben found atypical concepts (e.g., chicken) were responded to faster than typical concepts (e.g., robin) when a linguistic context was provided. Collectively, these findings demonstrate contextual factors that influence gradedness. Notice, however, that graded structure in those studies used typicality as a measure of gradedness and that typicality effects do not necessarily reflect category membership (Barsalou, 1987).

Context effects in categorization have also been demonstrated as a function of expert knowledge (Bailenson et al., 2002; Medin et al., 1997). Preliminary work in our laboratory suggests that background knowledge of natural categories influences category structure. In one study, individuals with different backgrounds in biological sciences classified artifactual and natural items. Results replicated the domain difference in category structure (Diesendruck & Gelman, 1999; Estes, 2003). Interestingly, though, individuals with a biology background judged artifactual and natural categories more absolute than individuals without a biology background. Although this finding warrants replication, it suggests knowledge of natural categories may influence the gradedness of artifactual categories. Therefore, expert knowledge in one domain may adjust the "default" classification scheme (Bailenson et al., 2002; Hampton et al., unpublished manuscript; Medin et al., 1997).

Conclusion

The finding of a positive relation of perceived subjectivity and gradedness indicates that category structure corresponds to one's beliefs of artifactual and natural categories. Whereas subjective beliefs result in graded category judgments, objective beliefs result in absolute category judgments. This positive relation is consonant with psychological essentialism, which suggests that subjective beliefs are a matter of opinion, open to interpretation, in contrast to objective beliefs, which are a matter of fact, susceptible to a correct classification. Moreover, domain differences in gradedness are amenable to individual differences in perceived subjectivity. Thus, gradedness may be attributable to differences in category beliefs across contexts.

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APPENDIX A

BORDERLINE ITEMS AND THEIR GRADEDNESS

Item	Category	Source	Gradedness
	Natural Kinds		
Pepper	VEGETABLE	B&C	0.03
pomegranate	FRUIT	B&C	0.06
Hemlock	TREE	B&C	0.1
Virus	ANIMAL	M&G	0.1
Yeast	ANIMAL	M&G	0.1
Gold	PRECIOUS STONE	M&G	0.13
Guava	FRUIT	B&C	0.13
Poet	ANIMAL	M&G	0.13
Rice	VEGETABLE	B&C	0.13
Avocado	FRUIT	B&C	0.16
bachelor button	FLOWER	B&C	0.16
Bat	BIRD	B&C	0.16
Coconut	FRUIT	B&C	0.16
Gourd	VEGETABLE	B&C	0.16
Heather	FLOWER	B&C	0.16
Kumquat	FRUIT	B&C	0.16
thunderbird	BIRD	B&C	0.16
Zircon	PRECIOUS STONE	M&G	0.16
Juniper	TREE	B&C	0.19
Leech	INSECT	M&G	0.19
Pearl	PRECIOUS STONE	M&G	0.19
Pumpkin	VEGETABLE	B&C	0.19
Sage	TREE	B&C	0.19
Sprout	VEGETABLE	B&C	0.19
Tomato	FRUIT	B&C	0.19
cucumber	FRUIT	B&C	0.23
cultured pearl	PRECIOUS STONE	M&G	0.23
mushroom	VEGETABLE	B&C	0.23
Olive	VEGETABLE	B&C	0.23
Paralysis	DISEASE	M&G	0.23
Quartz	PRECIOUS STONE	M&G	0.23
rhinestone	PRECIOUS STONE	M&G	0.23
Rutabaga	VEGETABLE	B&C	0.23
bacterium	ANIMAL	M&G	0.26
Catalpa	TREE	B&C	0.26
Currant	FRUIT	B&C	0.26
Hyacinth	FLOWER	B&C	0.26
Plankton	FISH	M&G	0.26
sandcrane	BIRD	B&C	0.26

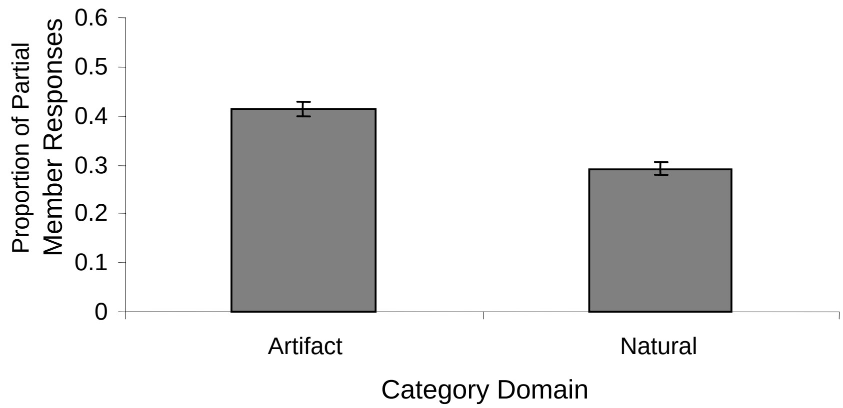
Item	Category	Source	Gradedness
Worm	INSECT	M&G	0.26
Dandruff	DISEASE	M&G	0.29
Deafness	DISEASE	M&G	0.29
Hominy	VEGETABLE	B&C	0.29
Lilac	TREE	B&C	0.29
philodendron	FLOWER	B&C	0.29
Sugar cane	VEGETABLE	M&G	0.29
duck-billed platypus	BIRD	B&C	0.32
Peanut	VEGETABLE	M&G	0.32
Stroke	DISEASE	M&G	0.32
Allergy	DISEASE	M&G	0.35
Blindness	DISEASE	M&G	0.35
Pimento	VEGETABLE	B&C	0.35
rhododendron	TREE	B&C	0.35
Rhubarb	FRUIT	B&C	0.35
Starfish	FISH	M&G	0.35
Depression	DISEASE	M&G	0.39
Forsythia	TREE	B&C	0.39
Jellyfish	FISH	M&G	0.39
Octopus	FISH	M&G	0.39
Seahorse	FISH	M&G	0.39
Shrimp	FISH	M&G	0.39
Crab	FISH	M&G	0.42
Fever	DISEASE	M&G	0.42
Food poisoning	DISEASE	M&G	0.42
Industrial diamond	PRECIOUS STONE	M&G	0.42
moon rock	PRECIOUS STONE	M&G	0.42
sassafras	TREE	B&C	0.42
schefflera	FLOWER	B&C	0.42
Ground ivy	FLOWER	B&C	0.45
Porpoise	FISH	M&G	0.45
sea anemone	FISH	M&G	0.45
silk flower	FLOWER	B&C	0.45
Sponge	FISH	M&G	0.45
Clam	FISH	M&G	0.48
heart attack	DISEASE	M&G	0.48
Lobster	FISH	M&G	0.48
Tooth decay	DISEASE	M&G	0.48
Ulcer	DISEASE	M&G	0.48
Clove	VEGETABLE	B&C	0.52
Squid	FISH	M&G	0.52
Oyster	FISH	M&G	0.58
	Artifactual		
sledge hammer	TOOL	M&G	0
Bureau	FURNITURE	B&C	0.13
dresser drawer	FURNITURE	B&C	0.13
kitchen set	TOY	B&C	0.13
rocket launcher	WEAPON	B&C	0.13

Item	Category	Source	Gradedness
ferris wheel	VEHICLE	M&G	0.19
hall tree	FURNITURE	B&C	0.19
Rickshaw	VEHICLE	B&C	0.19
Soldering iron	TOOL	M&G	0.19
Beanbag chair	FURNITURE	B&C	0.23
Conveyor belt	VEHICLE	M&G	0.23
Gondola	VEHICLE	B&C	0.23
computer	TOOL	B&C	0.26
Corduroy	CLOTHING	B&C	0.26
refrigerator	FURNITURE	B&C	0.26
workbench	TOOL	M&G	0.26
Escalator	VEHICLE	B&C	0.29
Mantel	FURNITURE	B&C	0.29
picnic table	FURNITURE	B&C	0.29
Shelves	FURNITURE	B&C	0.29
Stove	KITCHEN UTENSIL	M&G	0.29
Chair	WEAPON	B&C	0.32
Funnel	TOOL	B&C	0.32
spacecraft	SHIP	M&G	0.32
Drugs	WEAPON	B&C	0.35
hovercraft	SHIP	M&G	0.35
Pocket	CLOTHING	B&C	0.35
Stretcher	VEHICLE	M&G	0.35
trouble light	TOOL	B&C	0.35
Truck	TOOL	B&C	0.35
Varnish	TOOL	M&G	0.35
Dustpan	KITCHEN UTENSIL	M&G	0.39
garbage disposal	KITCHEN UTENSIL	M&G	0.39
Gun	TOOL	B&C	0.39
Shaver	TOOL	B&C	0.39
Toyboat	SHIP	M&G	0.39
waste basket	FURNITURE	M&G	0.39
Horse	VEHICLE	B&C	0.42
Mop	KITCHEN UTENSIL	M&G	0.42
Paint	TOOL	B&C	0.42
Rope	WEAPON	B&C	0.42
Tricycle	VEHICLE	B&C	0.42
Backgammon	TOY	B&C	0.45
Broom	KITCHEN UTENSIL	M&G	0.45
Clock	FURNITURE	B&C	0.45
dishwasher	KITCHEN UTENSIL	M&G	0.45
Rowboat	SHIP	M&G	0.45
Fork	WEAPON	B&C	0.48
Gas	WEAPON	B&C	0.48
houseboat	SHIP	M&G	0.48
music box	TOY	B&C	0.48
parachute	VEHICLE	M&G	0.48
Pillow	FURNITURE	B&C	0.48

Item	Category	Source	Gradedness
pogo stick	VEHICLE	M&G	0.48
record player	TOY	B&C	0.48
Rug	FURNITURE	M&G	0.48
String	TOY	B&C	0.48
surfboard	VEHICLE	M&G	0.48
Curtains	FURNITURE	M&G	0.52
fingernails	WEAPON	B&C	0.52
Guitar	TOY	B&C	0.52
Raft	SHIP	M&G	0.52
roller skates	VEHICLE	B&C	0.52
wheelchair	VEHICLE	B&C	0.52
bookends	FURNITURE	M&G	0.55
Canoe	SHIP	M&G	0.55
Cards	TOY	B&C	0.55
cuff links	CLOTHING	M&G	0.55
Drum	TOY	B&C	0.55
Racquet	TOY	B&C	0.55
Buttons	CLOTHING	M&G	0.58
Handbag	CLOTHING	M&G	0.58
Kayak	SHIP	M&G	0.58
Lifeboat	SHIP	M&G	0.58
skateboard	VEHICLE	M&G	0.58
Wig	CLOTHING	M&G	0.58
Car	WEAPON	B&C	0.61
musical instrument	TOY	B&C	0.61
Stereo	FURNITURE	B&C	0.61
handkerchief	CLOTHING	B&C	0.68
headband	CLOTHING	B&C	0.68

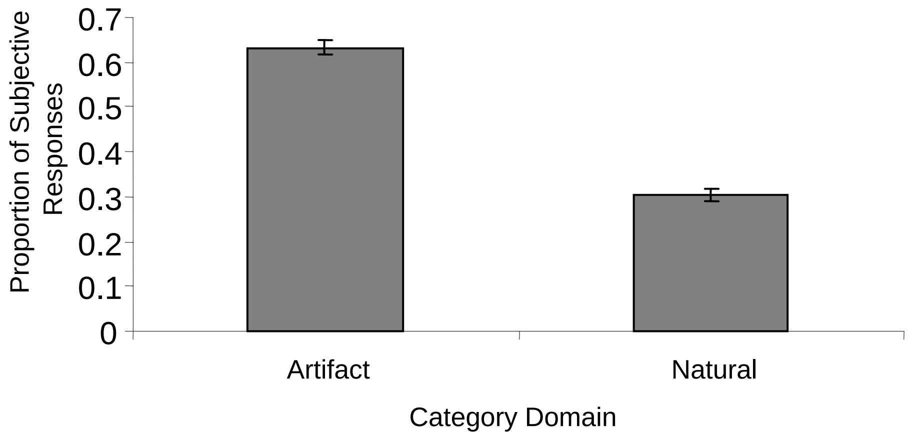
Note. “B&C” indicates that the item was sampled from Barr and Caplan (1987) and “M&G,” from McCloskey and Glucksberg (1978). Gradedness was the proportion of “partial member” responses.

Figure 1.



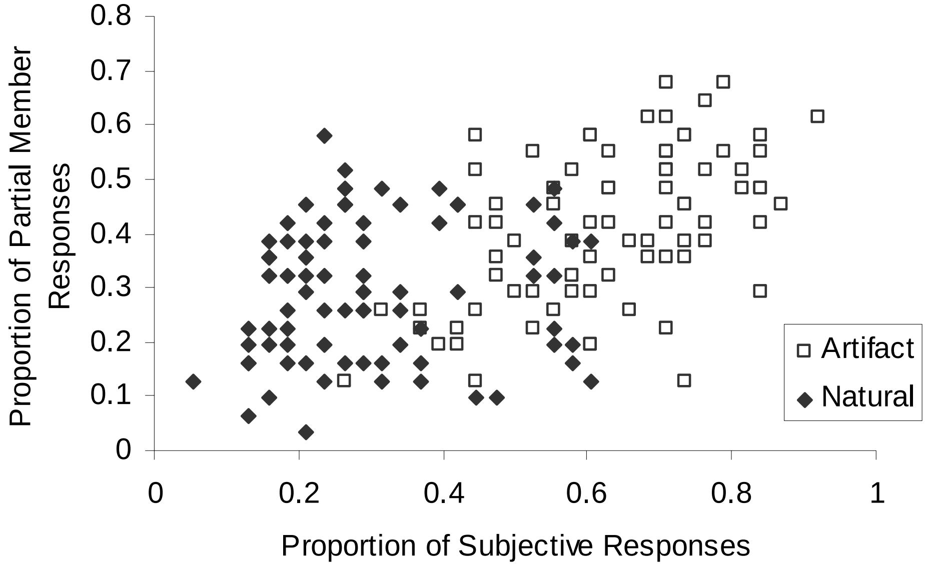
Note. Artifact categories were judged more graded than natural categories.

Figure 2.



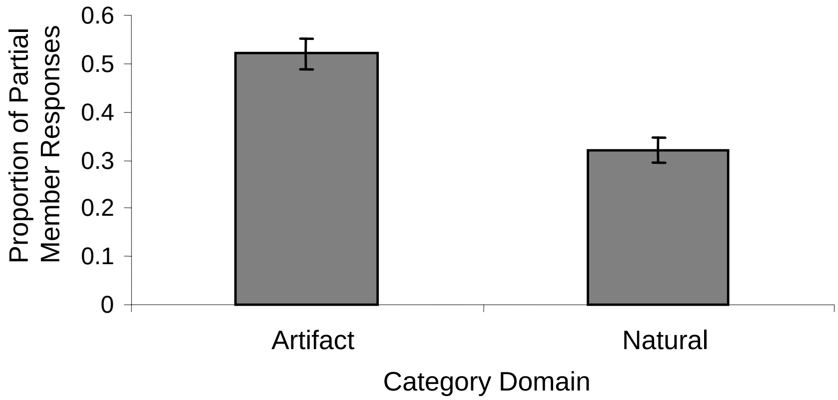
Note. Artifacts were judged more subjective than natural items.

Figure 3.



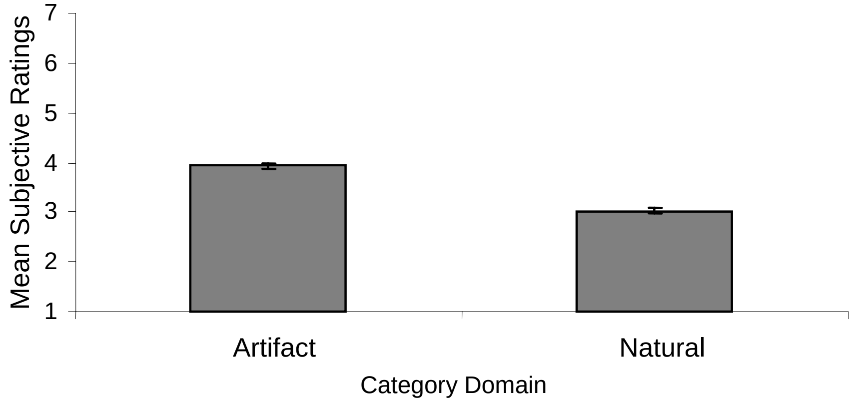
Note. Artifactual categories were more graded and judged with greater subjectivity than natural categories.

Figure 4.



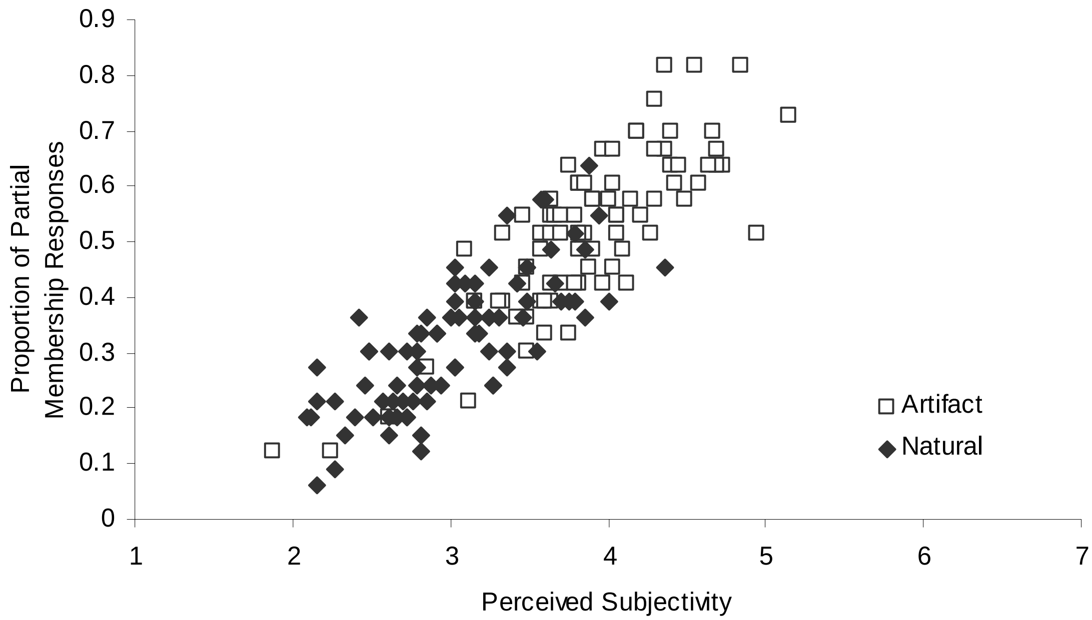
Note. Artifacts were judged more graded than natural items.

Figure 5.



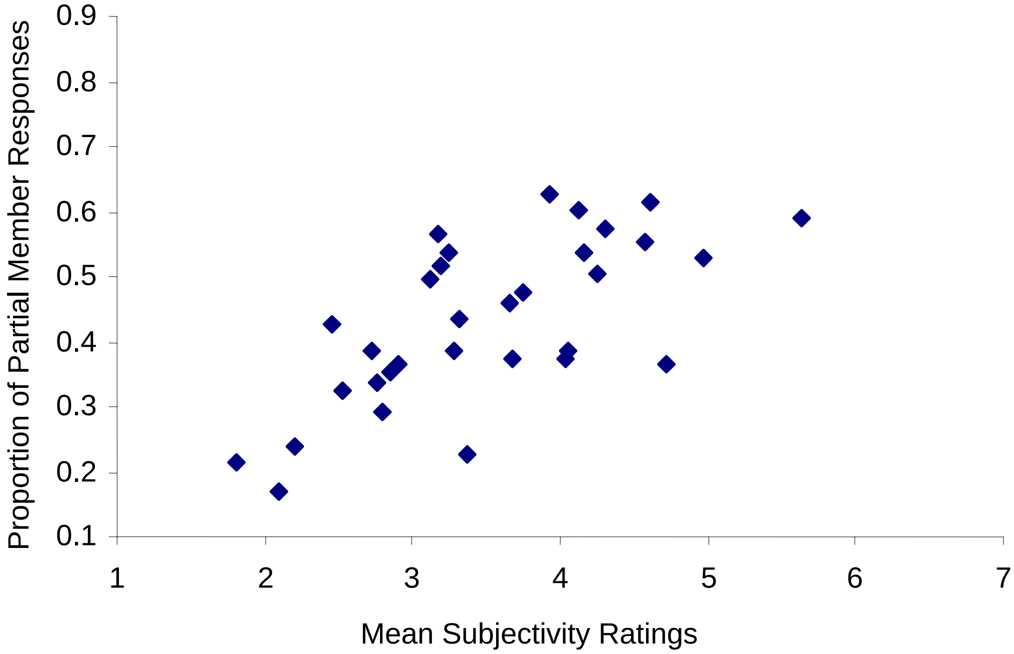
Note. Artifacts were rated more subjective than natural items on a scale from 1 (not at all subjective) to 7 (very subjective).

Figure 6.



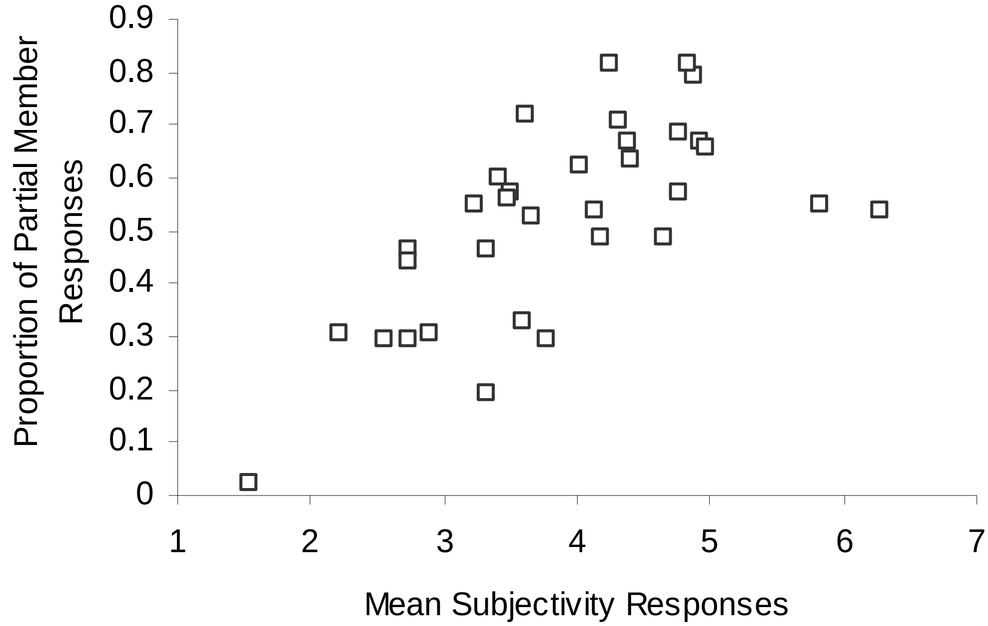
Note. Increased perceived subjectivity was positively related with increased gradedness across items.

Figure 7.



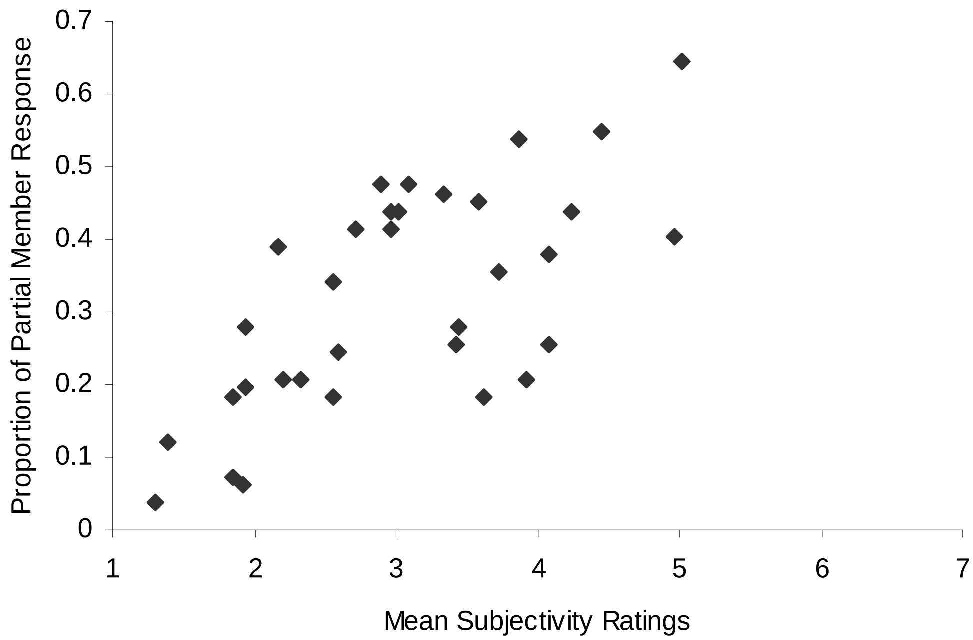
Note. Increased subjectivity was positively related to increased gradedness across participants.

Figure 8.



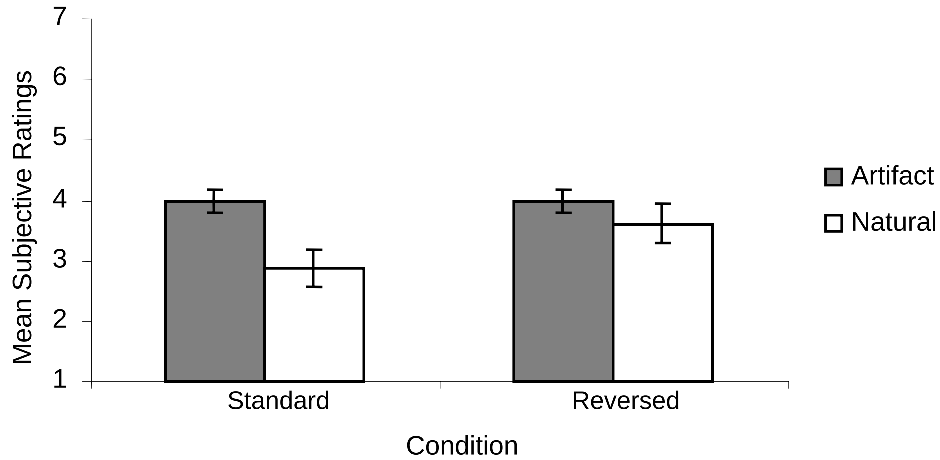
Note. Within the artifactual domain, mean subjectivity ratings were positively correlated with gradedness across participants.

Figure 9.



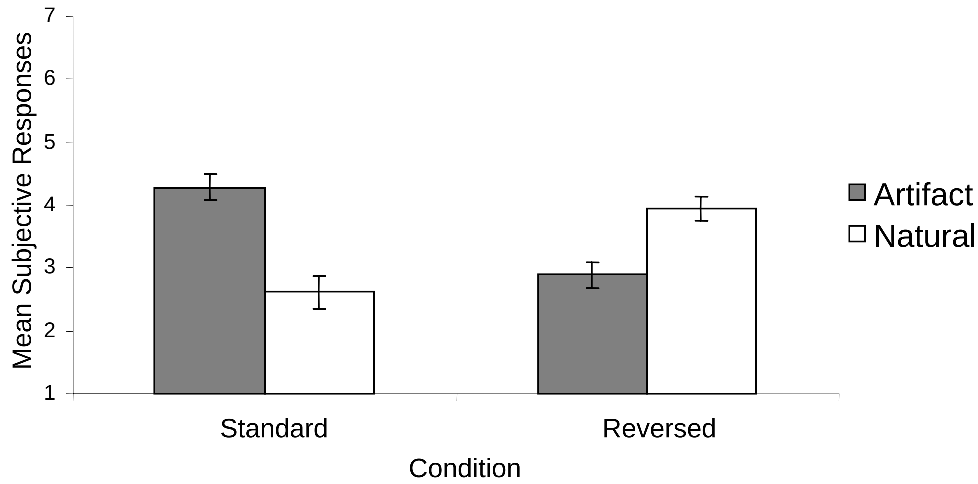
Note. Within the natural domain, mean subjectivity ratings were positively correlated with partial membership responses across participants.

Figure 10.



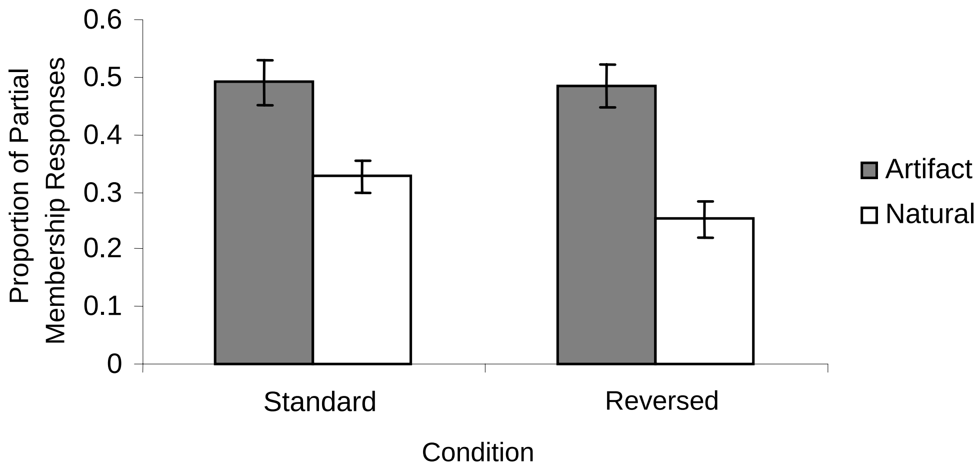
Note. Mean subjectivity ratings of critical artifactual and natural items for critical items were reliably different across conditions.

Figure 11.



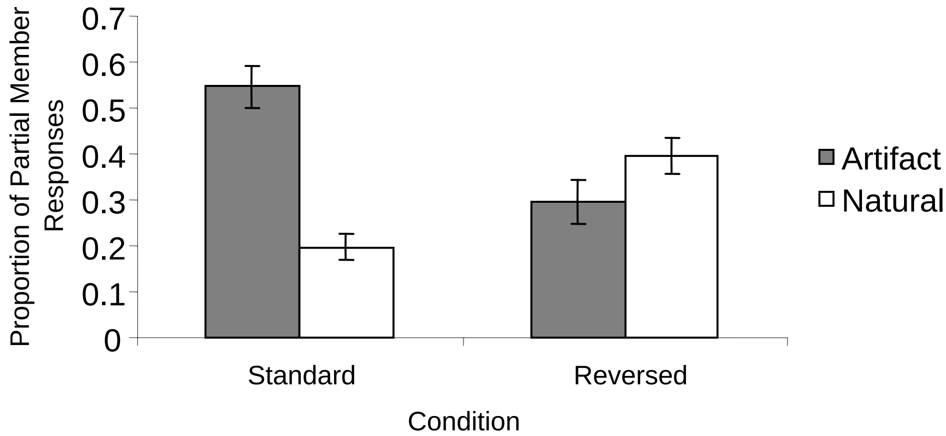
Note. Filler items in the artifactual domain were rated more subjective in the standard than in the reversed condition. In contrast, filler items in the natural domain were rated more subjective in the reversed than in the standard condition.

Figure 12.



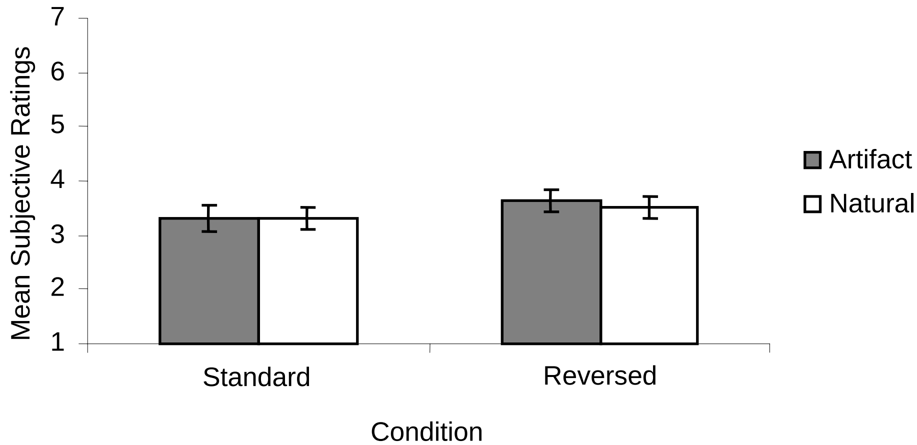
Note. Artifacts were judged more graded than natural items across conditions for critical items.

Figure 13.



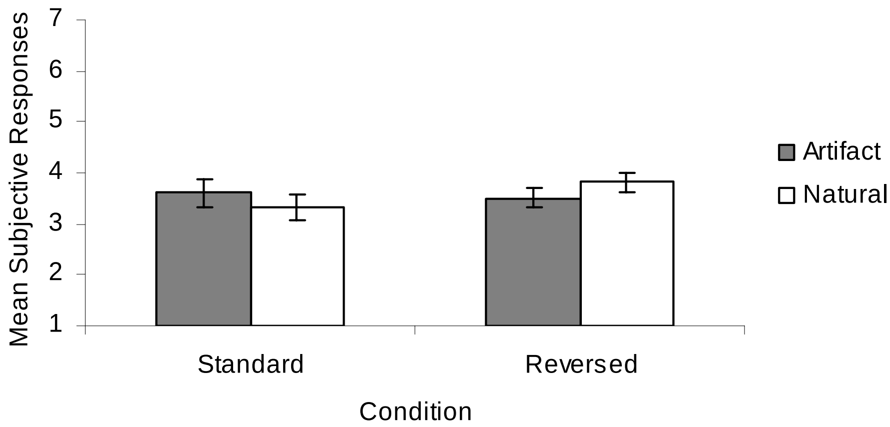
Note. Partial membership responses were reliably different across conditions for filler items.

Figure 14.



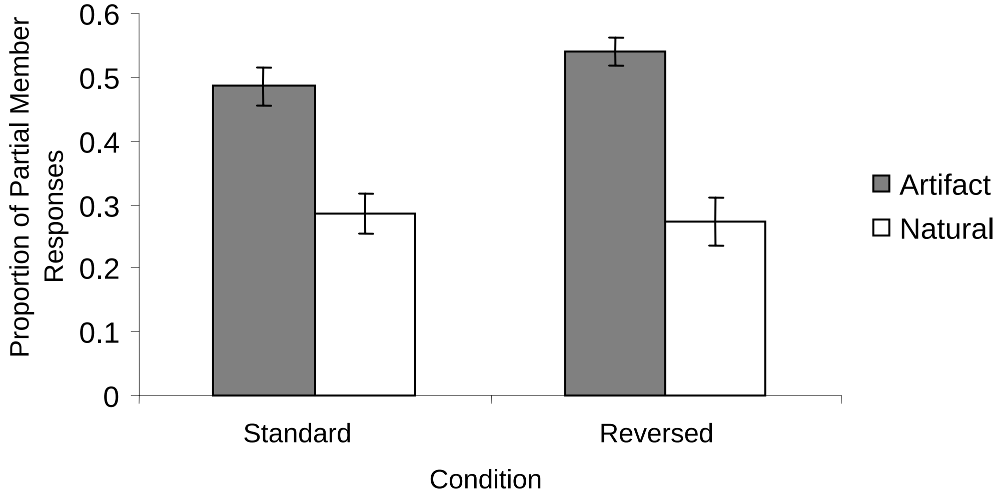
Note. Mean subjectivity ratings were not reliably different across conditions for critical items.

Figure 15.



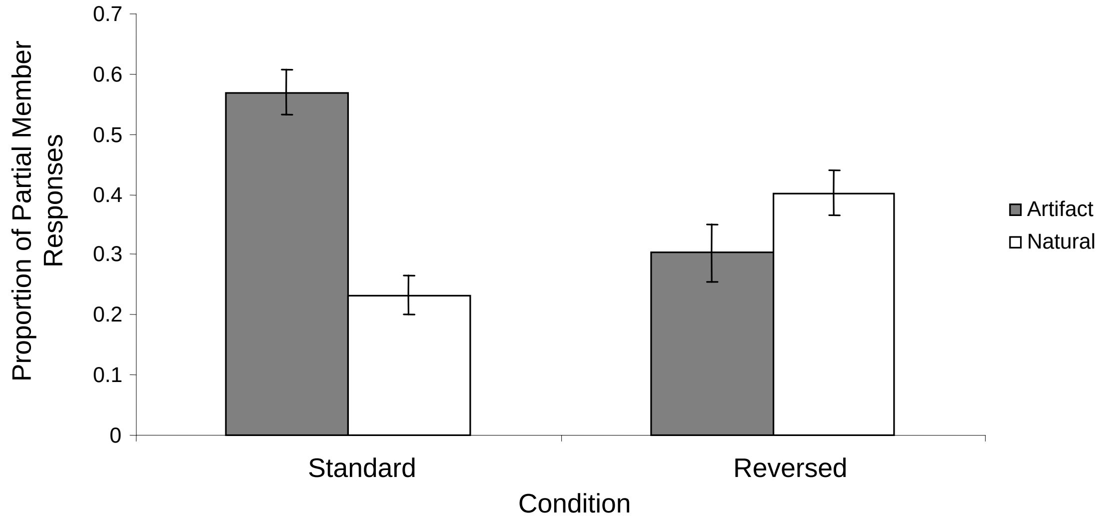
Note. Mean subjectivity ratings were not reliably different across conditions for filler items.

Figure 16.



Note. Artifacts were judged more graded than natural items across conditions for critical items.

Figure 17.



Note. Partial membership responses for artifactual and natural items were reliably different across conditions for filler items.