Discrete Dimension Accessibility in Multidimensional Concepts: the Noun - Adjective Distinction

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Abstract

Previous studies have identified that conceptual categories corresponding to nouns exhibit semantic domain effects: (1) classification into biological ones reflects a non-additive consideration of their defining dimensions whereas classification into artefactual and, presumably, social nouns is based on an additive one (2) nominal biological concepts are less graded than artifacts. Nevertheless, much uncertainty exists about the structure of conceptual categories corresponding to multidimensional adjectives. We propose that the effects observed for concepts corresponding to nouns are connected to a property we term *discrete dimension accessibility* and ask how it is manifested in multidimensional concepts corresponding to adjectives. We then hypothesize that (a) ratings of dimension-counting structures can be used as a diagnostic for these properties (b) the dimensions of multidimensional concepts corresponding to adjectives are inherently discrete. We report an acceptability rating experiment involving 42 adult Hebrew speakers revealing that with nouns, dimension-counting constructions with artefactual and social predicates are rated higher than ones with biological predicates, hence confirming (a). With adjectives, ratings for dimension-counting constructions remained high across the domain manipulation, hence confirming (b). We argue that the interaction between discrete dimension accessibility and lexical category indicates that lexical distinctions interact with conceptual ones.

Keywords: Conceptual categories, Lexical category, Adjectives, Nouns

The past five decades have seen extensive research of the mechanisms underlying the way humans categorize their experiences into *concepts* – mental representations that help us understand the world (Carey, 2009; Medin & Smith, 1984; Murphy, 2002, among others). The present study examines a particular aspect of how we map concrete objects (people and things) into mental representations, namely the factors underlying a decision that a given object falls under a category corresponding to a concept (henceforth: *conceptual category*). To refer to this type of decision, we will use the term *classification* (often used interchangeably with the term *categorization*, Hampton 1979, 1989, 1997; Keil, 1989; Medin, 1989; Murphy & Medin, 1985; McCloskey & Glucksberg,1978; Murphy, 2002; Nosofsky, 1988; Rips, 1989; Rosch, 1973; Rosch & Mervis, 1975; Smith & Medin, 1981, among many others). We present rating data on the classification of conceptual categories corresponding to nouns and adjectives from different semantic domains (biological vs. social and artefactual) in order to investigate the role of dimensions (e.g., Gärdenfors, 2000; Hampton, Storms, Simmons, & Heussen, 2009) in classification decisions.

Category Classification and Dimensions

To demonstrate what we mean by classification, let us follow an example from Murphy (2002) and consider a person's encounter with a tomato they have never seen before. As people rarely experience the same tomato twice, that person's likely decision that this object is a tomato will be based on their success in classifying it under their conceptual category TOMATO.

Classification operates under the conceptual system that is non-linguistic in its nature. Nevertheless, it is a common assumption among researchers studying language that the conceptual system interfaces with the lexical component of linguistic knowledge (Fodor 1975; Pinker 1994; Sperber & Wilson 1997, among others). The current study's object of interest is hence the relationship between linguistic distinctions and conceptual classification. Accordingly, we limit the scope of this investigation to conceptual categories corresponding to single vocabulary items in a given language.

The various models offered to capture the principles that guide classification (cited above) are distinguished by the internal architecture they attribute to conceptual categories and the membership criteria they propose. Nevertheless, many of them share the central assumption that for an object to be classified under a conceptual category, it needs to, in some way, exhibit *features* (also named *properties* and *attributes*) associated with membership in this category. For example, in the instructions section of the first experiment they report, designed to obtain patterns of the distribution of features ('attributes') of members of certain categories, Rosch and Mervis (1975) provide examples for features that may be associated with the conceptual category DOG: having four legs, barking, having fur, etc. When discussing the conceptual category HAT, Smith and Medin (1981) assume that such an object may be associated with the properties of having an aperture that is the size of a human and being manufactured with the intent of a human wearing it.

Features like the ones presented above are often viewed as values on *dimensions* (Estes & Glucksberg, 2000; Hampton, 1997; Hampton et al., 2009; Medin & Schaffer,1978; Murphy, 2002; Gärdenfors, 2000; Gärdenfors & Williams, 2001) . For example, Medin and

Schaffer (1978) consider *small* to be a value on the *size* dimension, *blue* to be a value on the color dimension and *triangle* to be value on the *form* dimension. We adopt a definition from Gärdenfors (2000, 2004), which views dimensions as a set of values (features) in a given domain. For example, the values of the dimension *size* may be *big*, *medium* and *small*. Accordingly, the examples above suggest that to be classified under HAT an object is assessed in relation to the dimensions of *shape* and *purpose*. In a similar vein, to be classified as DOG an object is assessed in relation to the dimensions *sound*, *shape* and *texture*.

Concepts like DOG and HAT share two important characteristics. First, as many other objects in the concrete world, classification under them depends on multiple dimensions (Hampton et al., 2009). In contrast, classification under concepts like TALL or TRANSPERANT is a matter of degree in a single dimension (Kennedy & McNally, 2005; Kennedy, 1999, 2007; Schwarzschild, 2002). Classification under TALL is merely a matter of *height*. Classification under TRANSPERANT is a matter of *opacity*. The second characteristic shared by DOG and HAT, is the part-of-speech, or lexical category, associated with their linguistic manifestation. Both functional and formal approaches to grammar propose models defining *lexical categories* (also referred to as *parts-of-speech* or *form-classes*) such as noun, verb and adjective (Baker, 2003; Bolinger, 1967, 1980; Chomsky, 1970, 1982;Finegan, 2006; Jackendoff, 1977; O'Grady, Dobrovolsky, & Aronoff , 1997; Pustet, 2003; Stassen 1997; Stowell, 1981; Wetzer, 1996; Wierzbicka 1980, 1986, for a review see Baker & Croft, 2017). As elaborate in above, functionalist approaches typically use semantic evidence to define lexical categories, whereas formal approaches do not. Further, even models of grammar that reject the assumption of one lexicon that encodes words (Arad, 2005; Borer, 2003; Halle & Marantz, 1993; Marantz,1997) include distinctions corresponding to lexical categories, namely category determining heads that merge with category neutral ‘atomic roots’, such as V(erbs) and N(ouns), in syntax.

Hence, part-of-speech models agree that the use of two items in the same range of grammatical constructions in a given language indicates that they belong to the same lexical category, part-of-speech or form-class, whereas a dissociation in these ranges suggest that they do not (Baker & Croft, 2017). For example, Nouns tend to occur in argument position, where their main function is to refer to objects (as in *The* ***boys*** *hugged*), whereas adjectives typically occur in predicate or modifier position (as in *Bill is* ***tall*** and *a* ***tall*** *boy*, respectively). In many languages, for adjectives to occur in predicate position, they have to combine with a copula (such as *is*) or an affix. In addition, unlike verbs, adjectives rarely inflect for tense and aspect.

Accordingly, the linguistic manifestations of the conceptual categories HAT and DOG and other concrete objects are typically associated with the lexical category (or lexical head) noun. The linguistic manifestations of the conceptual categories TALL and TRANSPERANT, on the other hand, are associated, at least in some languages, including English, with the lexical category adjective.

Nonetheless, HAT and DOG are different in respect to another aspect discussed in the literature, namely the semantic domain of the objects they denote. Studies on classification (Estes 2003, 2004; Hampton, 1997; Hampton et al., 2009; Wattanmaker, 1995) often use this term to group and distinguish classes of conceptual categories. Accordingly, animals and plants are termed *biological* (or *natural*) categories, manmade objects are termed *artefactual* categories and human properties and professions are referred to as *social* categories. Based on this, DOG is a biological category whereas HAT denotes an artefactual category. Studies have shown that semantic domain has implications on decisions concerning classification (Estes 2003, 2004; Hampton et al.2009; Wattenmaker, 1995). While these studies observed such effects in categories corresponding to nouns (in English), much uncertainty still exists about classification strategies associated with the conceptual representations corresponding to adjectives. We elaborate on these studies below.

As demonstrated, in contrast to conceptual categories manifested as nouns (henceforth: nominal concepts) like DOG or HAT, which encode multiple dimensions, classification under many adjectives like TALL or TRANSPARENT is a matter of degree in a single dimension. In the literature, these adjectives are typically classified as gradable (Kennedy & McNally, 2005; Kennedy, 1999, 2007; Schwarzschild, 2002). For our current purposes, let us name them *dimensional* adjectives. Importantly, in the case of many other concepts manifested as dimensional (i.e. gradable) adjectives, classification is clearly not a matter of a degree in a *single* dimension. Classification under HEALTHY, ATTRACTIVE or MYSTERIOUS is sensitive to *multiple* dimensions (Bartsch, 1986; Hoeksema, 1995; Kamp, 1975; Klein, 1980; Landman, 1989; Sassoon, 2012, 2016). For example, classification under HEALTHY is sensitive to dimensions such as *blood pressure*, *temperature* and *sugar intake*. Classification under ATTRACTIVE is sensitive to *appearance*, *behavior* and *style*, and so on. Let us call this type of adjectives *multidimensional*.

Concepts corresponding to multidimensional adjectives and concepts corresponding to concrete nouns are hence similar in that they both encode multiple dimensions. The current paper asks whether the way multiple dimensions contribute to classification decisions correlates with lexical category.

Models of lexical categorization can be divided according to whether or not they introduce a generalization about the type of conceptual classes that lexical categories tend to denote. Let us refer to models that include a conceptual element as *conceptual accounts* and the ones that do not as *non-conceptual accounts*. We elaborate on these models and the accounts they propose for the noun/adjective distinction below.

Our study is similar to conceptual accounts in that it investigates potential regularities in classification into categories corresponding to nouns and adjectives (henceforth: nominal and adjectival concepts). Nevertheless, our goal is not to identify the notions, semantic-classes or conceptual properties that multidimensional nouns and adjectives tend to describe, but to characterize consistencies in classification into conceptual categories corresponding to them. Specifically, we are interested in identifying how values on different dimensions of a concept (e.g., TOMATO) exhibited by a given object (e.g., a tomato) jointly contribute to classification decisions.

For this purpose, we conducted an acceptability rating experiment in which Hebrew speakers were presented with adjectives and nouns embedded under constructions we refer to as *dimension-counting* structures with an additional manipulation of semantic domain. As we argue below, these constructions are predicted to detect the domain effects previously observed with nominal concepts.

In the next sections, we overview the findings of previous studies that examined domain effects on classification (Estes 2003, 2004; Hampton et al. 2009; Wattanmaker 1995). Based on further inspection of their stimuli and the findings of Sassoon (2012) and Sassoon and Fadlon (2017), we raise the hypothesis that in addition to the domain of a concept, the lexical category of its linguistic realization also correlates with classification decisions. We then report the findings of an experiment designed to test this hypothesis.

The experiment adopted the methodology used in Sassoon and Fadlon (2017) who conducted an acceptability rating experiment, in which English speakers were asked to rate the naturalness of simple classification statements (*This bird is a robin*) embedded under quantificational (*This bird is a robin in some respect*) and comparative (*This bird is more robin than that bird*) constructions. As we explain in more detail below, the compositional semantics of these constructions, which we label *dimension-counting* structures, predicts that they can serve as a diagnostic for the domain effects on classification previously observed in the literature (Estes 2003, 2004; Hampton et al. 2009). This assumption receives support from Sassoon and Fadlon's (2017) findings, which revealed an asymmetry between the naturalness of these constructions with artifacts and social nouns as predicates as compared to their naturalness with biological nouns as predicates. Further, as this asymmetry was not observed when the same subject nouns appeared with adjectival predicates, their results also indicate a contrast in classification into adjectival and nominal conceptual categories.

In the current study we adopted the task Sassoon and Fadlon used and aimed to replicate their main findings with Hebrew speakers. Importantly, the current study managed to overcome methodological shortcomings found in their study. We elaborate on this point below.

An additional contribution of the current study is that, as far as known, it is the first to investigate domain effects on classification by targeting Hebrew, whereas previous attempts have mainly focused on English (with the exception of Dutch, e.g. Verheyen, Heussen, & Storms, 2011). This means that a replication of previously observed domain effects in the current study would add justification for viewing these patterns as reflecting general conceptual patterns, rather than indicating language- or culture-specific behaviors.

Our results from Hebrew replicate the asymmetry observed in Sassoon and Fadlon (2017) and provide further indication that while the domain of the classified entity is indeed reflected in classification into nominal conceptual categories, it is not reflected in classification into concepts corresponding to multidimensional adjectives. We conclude by discussing implications on the noun/adjective distinction. Specifically, we argue that this interaction between domain and lexical category indicates that lexical distinctions such as adjective and noun interact with conceptual ones.

Domain Effects on Classification

Let's first turn to findings from classification - the way objects are mapped onto mental representations. Estes (2003) reports a series of three experiments designed to examine domain effects on category structure as reflected in classification decisions. In the first two experiments subjects were asked to indicate the level of membership of an object in a given category. In the third experiment, subjects had to compare the membership levels of two items in a given category. Performance revealed that membership in artifact (e.g., HAMMER) categories was more likely to be judged as partial and unequal, whereas membership in biological categories (e.g., BIRD) tended to be an absolute matter and concludes that artifact categories are more *graded* than biological ones. Estes defines graded categories as ones in which membership is a matter of degree. While this correlates with the linguistic property semanticist term ‘gradability’, Estes’s concern is the internal structure of conceptual categories. Hence, to avoid possible confusion, we refer to the property discussed in Estes (2003) as *gradedness*, defined as the extent to which membership in a conceptual category is a matter of degree.

Estes (2004) further demonstrates that graded category structure is not a reflection of graded *certainty* in membership, as artifacts were also judged with greater confidence than biological categories were. He suggests that since artifact category membership is a subjective matter of opinion, whereas biological category membership is an objective matter of fact (Kalish, 1995; Malt, 1990; Murphy, 2002), the former cannot be applied incorrectly and are therefore rendered with confidence. Judgments on objective biological category membership, on the other hand, may be incorrect, hence involve hesitation.

More recently, following Estes’s (2004) distinction between objective and subjective category membership, Hampton et al. (2009) hypothesized that since membership in biological categories is considered a factual matter driven by an underlying genetic cause or some notion of essence, classification into them would *not* rely on an additive calculation, i.e. a calculation in which the values on each dimension make an independent contribution to classification decisions. As a common cause entails all of their defining features, the absence of any one of them was predicted to act strongly to reduce confidence in its presence, thus in category membership. Let us refer to classification in which dimensions do not make independent contribution to the end decision as *non-additive*.

By contrast, because membership in artefactual concepts is typically considered more a matter of subjective opinion with a much looser causal structure between dimensions (like an artifact's appearance, use, and intended use), classification in artifact-denoting nouns would be *additive*. Accordingly, each of their dimensions was predicted to have an independent effect on classification. An additive classification strategy can be modeled as based on the weighted sum of an object's dimensional degrees. This is demonstrated in (1)a, where x represents an object, fF1, ..., fFn are its dimensional degrees and wF1, ..., wFn are their weights (Rosch & Mervis 1975; Tversky 1977).

The simplest *non*-additive model capturing both the importance of the relation between dimensions and the strong implications of the absence of one of them in biological categories would involve a multiplicative calculation of membership. This means that classification would be based on the weighted product of an object's dimensional degrees, as demonstrated in (1)b (Hampton et al., 2009; Medin & Schaffer, 1978; Wattanmaker, 1995).

(1) a. $wF1fF1(x) + wF2fF2(x) + wF3fF3(x) \ldots + wFnfFn(x)$

b. $fF1(x)^{WF1} \times fF2(x)^{WF2} \times fF3(x)^{WF3} \ldots \times fFn(x)^{WFn}$

To test whether this distinction holds between domains, Hampton et al. (2009) asked speakers to characterize biological and artefactual entities when the context established them as exhibiting the dimensions of two categories. For example, in one scenario featuring a biological entity, a historical nuclear accident near a remote island resulted in the evolution of creatures with some features of lobsters and some features of crabs. In another scenario, featuring an artefactual entity, a secluded community in a remote area had the habit of using artifacts in multiple ways; for instance, some pieces of clothing had features of both a scarf and a tie. Participants were asked to help scientists classify the entities. In line with non-additive similarity, the effects of the dimensions of biological categories were often dependent on the presence or absence of other dimensions. By contrast, in line with additive similarity, the effects of the dimensions of artefactual categories were independent and additive. Moreover, in line with non-additive similarity, hybrids of two biological categories were often classified in neither one of the kinds (since absence of one feature dropped their similarity to the category and thus their classification probability). By contrast, in line with additive similarity, hybrids of artefactual categories were often classified in both categories (as the absence of a few dimensions hardly affects the overall additive similarity of an entity).

Hampton et al. (2009) further refers to the findings of a previous study (Wattanmaker, 1995), reporting a series experiments asking participants to categorize social concepts (human traits or occupations) and object categories including animals and artifacts based on a set of features. This study found that categorization of social concepts was often based on counting the number of matching features. Categorization under object categories on the other hand, was clearly influenced by relations between dimensions and heavily weighted single dimensions. Wattanmaker (1995) did not address the difference between artifacts and biological nouns, classifying both as object categories and Hampton and his colleagues did not examine social concepts. However, based on the contrast they found between artifacts and biological concepts, Hampton et al. (2009) predicted that social concepts will show results similar to those of artifacts, as it should be more likely that a person with a mixed set of features will belong in both contrasting categories (e.g. PHYSICIAN and BUTCHER) than to neither.

In sum, the picture emerging from previous studies is that biological and artefactual nouns differ not only in gradedness (Estes 2003, 2004) but also in their classification strategy (Hampton et al., 2009). Essentially, classification strategies correspond with gradedness levels.

Leaving aside questions about causality, it appears that classification based on additive averaging would inevitably co-occur with high levels of gradedness. Both properties assume a scale of membership, where entities that share *n+1* features with the prototype are better members than entities that share *n* features. Further, both additivity and gradedness are made possible when each of the defining dimensions (times its weight), hence their subsets, can be independently added and, in some cases (i.e. when dimensions are binary and are of equal weight; Wattanmaker, 1995), counted. On the other hand, classification based on non-additive averaging of dimensions would inevitably co-occur with a reduced level of gradedness, since in this case the values in different dimensions depend on each other, hence cannot be considered independently for comparisons of category membership levels or partial membership judgments. Therefore, both non-additivity and lower levels of gradedness denote a definition of membership in which the absence of one defining feature acts strongly to reduce membership.

In the remainder of this paper we use the term *discrete dimension accessibility* to refer to both gradedness (Estes 2003, 2004) and additivity (Hampton et al., 2009). A definition is provided in (2) below.

> (2) A concept's defining dimensions are discretely accessible when values on each of them make independent contributions to classification decisions.

Discrete dimension accessibility is hence a property of conceptual categories for which classification decisions reflect an independent contribution of values on their defining dimensions.[1]

Nouns and Adjectives

As mentioned above, the noun/adjective distinction is assumed by both functional and formal approaches. This section provides a review of the way part-of-speech models address this distinction.

The vast majority of lexical categorization models are functional and introduce conceptual definitions or distinctions to capture generalizations about parts of speech in general, and consequently about the noun/adjective distinction. We refer to these models as *conceptual-models*. Bolinger (1967, 1980) and Wierzbicka (1980, 1986) propose that nouns *categorize*, i.e. denote a large number of holistic properties that classify their referent, whereas adjectives *describe* by adding a single property to that set. This view can be traced back to Jespersen (1924) (as quoted in Bhat, 1994), which argued that ‘substantives’ (nouns) denote complex qualities, whereas adjectives single out one.

It is true that nouns like *bird* or *psychologist* are associated with multiple dimensions, whereas adjectives like *tall*, are associated with one, i.e. height. However, recall that in fact, many adjectives like *healthy* or *attractive* are multidimensional. A person may be healthy in some respects, but not in others (Bartsch, 1986). This complexity is also typically ignored by many formal semanticists, who do not distinguish between dimensional (*tall*) and multidimensional adjectives (*healthy*) and model all gradable adjectives (e.g. *tall* and *healthy*, as opposed to *meteorological*) by means of a single dimensional scale per context composing a relation between individuals and degrees (cf., Heim, 2000; Kennedy & McNally, 2005; von Stechow 1984, 2007, a.o.). As we explain above, our study focuses on multidimensional adjectives which, like common nouns, encode *multiple* dimensions. This property provides a common ground which enables an identification of differences in discrete dimension accessibility between multidimensional concepts corresponding to adjectives and nouns.

Other conceptual approaches assume continua of finer grained concepts, semantic classes or conceptual properties, in which the boundaries of lexical categories vary across languages. These continua range from typically nominal concepts to typically verbal concepts, with typically adjectival concepts in the middle. Givón's (1979) continuum ranges from permanent/inherent states (nouns) through transitory states (adjectives) to transitory processes (verbs). Dixon (1982) shows that age (e.g., *old*), dimension (*small*), value (*good*) and color (*blue*) concepts are encoded as adjectives even in languages with small adjectival classes. Other concepts like physical property (*strong*), speed (*slow*) and human propensity (*angry/clever*), are encoded as adjectives only in languages with large adjectival classes. Further, when they are not encoded as adjectives, physical property and speed tend to be nouns, whereas human propensities tend to occur as verbs. Several models (Wetzer, 1996; Stassen 1997; Pustet, 2003, a.o.) provide conceptual hierarchies along the parts of speech continuum based on this classification. For example, Stassen (1997) proposes a hierarchy, which ranges from objects (identified with nouns) to actions (identified with verbs): object < material, gender < value, age, form< dimension< color< physical properties < human propensity <action (see review in Baker & Croft 2017). Finally, Croft's (2001) 'conceptual space' crosses discourse functions (reference, modification and predication) with broad semantic classes (object, property and action). Parts of speech can then emerge from the prototypical class for each function.

Finally, in the generative tradition, parts of speech are defined by the abstract formal categories +/-N and +/-V (Chomsky 1970, 1982; Jackendoff, 1977; Stowell, 1981; see review in Baker, 2003; Baker & Croft, 2017) as opposed to conceptual consistencies. The value of these features is taken to represent the essence of lexical categories, which, among other things, determines their structural behavior. Nouns are hence defined as [+N,-V], verbs as [-N, +V] and adjectives as exhibiting the properties of both. In Baker's (2003) model, verbs are defined by their ability to have a specifier in syntactic structure [=+V, -N], nouns are defined by their ability to bear a referential index [=-V, +N] , and adjectives are defined by having neither of those positive properties [-N,-V]. In his view, then, unlike early generative models, the features that define how generative principles apply are not arbitrary, but substantive properties. This view is similar to early generative models in maintaining that adjectives are defined by different values of the same features that define nouns and verbs and in not including a generalization about the types of concepts denoted by the different parts of speech.

The Noun/Adjective Distinction and Discrete Dimension Accessibility

Studies on classification characteristically overlook the noun/adjective distinction. Nonetheless, a closer inspection of the stimuli used in the ones overviewed above, suggests that this distinction may have affected their findings. First, many of the experiments reported in Wattanmaker (1995) used samples of social concepts including many multidimensional adjectives (e.g., *friendly, timid*) and samples of biological concepts consisting of just nouns. On its own, this means that Wattanmaker's conclusion may be confounded by the noun-adjective distinction. Further, as Estes' (2003,2004) and Hampton et al.'s (2009) stimuli consisted exclusively of nouns, these studies add validation to the existence of domain effects only with regard to nouns, whereas the classification into concepts corresponding to multidimensional adjectives remains unaddressed.

Are Adjectival Dimensions Inherently Discrete?

Many adjectives, at least dimensional (*tall*) and multidimensional ones (*healthy*), are context dependent (Kennedy, 2007; Klein, 1980; Schwarzschild, 2006; McNally & Stojanovic, 2015 ; Solt, in progress, among others). Two ways in which this characteristic is expressed are the interpretations of adjectival classification statements like the ones we use in the study reported below (e.g. *This bird is healthy*) and the denotation of NPs with an adjectival modification (e.g. *a healthy bird*). It seems that the denotation of the adjective in both of these structures is sensitive to the conceptual category of the entity that is being classified or modified. The dimensions of HEALTHY relevant for *bird* are different from the ones relevant for *child*. If the defining dimensions of multidimensional adjectives are sensitive to the entity that they modify or that is being categorized into them, then choosing the subset of those that are relevant for the entity in question from all the dimensions associated with the adjective should be readily available. A property like discrete dimension accessibility would allow this contextually dependent sub-setting needed for classification of entities into adjectival categories. We hence hypothesize that the category defining dimensions of multidimensional adjectival concepts are always discretely accessible.

Further support for the hypothesis that conceptual categories corresponding to multidimensional adjectives exhibit inherent discrete dimension accessibility comes from the results of a corpus study reported in Sassoon (2012). It is known that exception phrases (e.g. *except for*) are modifiers that weaken generalizations manifested by universal quantifiers (as in *everyone except*), or negated existential ones (as in *nobody except*) (Fox & Hackl, 2006; Hoeksema, 1995; Moltmann 1995; von Fintel, 1994). This is reflected in the contrast between (3)a and (3)b:

(3) a. Everyone/nobody is happy except for Dan.

b. #Someone is happy except for Dan.

Sassoon analyzed more than 1300 naturally occurring exception phrases in English preceded by multidimensional adjectives and discovered that more than one third of them were ‘dimensional uses’. These are uses of exception phrases that do not include an explicit quantifying expression (e.g. *everything*/*nothing*), in which the excluded element is one of the adjective’s defining dimensions (e.g., *Dan is healthy except for high cholesterol*). Given the high proportion of dimensional uses, Sassoon suggests that the interpretation of multidimensional adjectives inherently involves quantification over their defining dimensions, even when they are used without a quantifying expression.

Generalized quantifier theory recasts the interpretation of quantifiers in terms of cardinalities of sets (Barwise & Cooper, 1981). This means that quantificational binding can be modeled as based on counting of elements. For example, the truth conditions of (4)-(6) suggest that the cardinalities of the sets of nurses and healthy nurses are counted; (4) is true if and only if (=iff) at least two nurses are healthy. (5) is true iff all nurses are healthy and (6) is true iff there are more healthy than unhealthy nurses.

(4) Some nurses are healthy.

(5) All nurses are healthy.

(6) Most nurses are healthy.

In other words, truth-values of quantificational statements reflect the outcome of the counting of elements in the intersection of the two sets upon which this operation takes place (i.e. $|\text{nurses} \cap \text{healthy}|$).

Let us return to the issue of conceptual classification strategy. Whereas additive averaging of dimensions boils down to a mere counting of features in certain cases (i.e. when dimensions are binary and are of equal weight; Wattanmaker, 1995), these circumstances do not suffice for non-additive averaging to reduce to counting. Hence, it seems that Sassoon’s (2012) suggestion that the interpretation of adjectives inherently involves implicit quantification, i.e. reflects counting of dimensions, implies that classification decisions regarding adjectival conceptual categories are consistent with additive dimension integration, hence that adjectival conceptual categories exhibit inherent discrete dimension accessibility.

Current Study

If adjectival conceptual categories exhibit inherent discrete dimension accessibility, they should demonstrate this property across domains. To test this prediction, we embedded simple classification statements (7) under quantifications (8) or comparisons (9).

(7) a. This bird is a robin.

b. This bird is healthy.

(8) a. This bird is a robin in some respect.

b. This bird is healthy in some respect.

(9) a. This bird is more a robin than that bird.

b. This bird is more healthy than that bird.

The characteristic that makes the structures in (8) and (9) ideal for our purpose is that they bind their arguments under semantic operations that involve counting, hence require discrete dimension accessibility. As mentioned, the contribution of the quantificational operator SOME to the truth conditions is the counting of the number of elements in the intersection of two sets. Put in the terms of our current interest: (7)b conveys that the number of dimensions of the concept HEALTHY this bird possesses is bigger than zero. Comparative structures like those in (8) also seem to involve counting of elements. Indeed, cardinality has been argued to be a very common scale in comparative structures (Constantinescu, 2011; Morzycki, 2011, 2012; Wellwood 2014, 2015). This means that assigning meaning to (8)b involves a comparison of the number of HEALTHY dimensions one bird possesses with the number of HEALTHY dimensions the other one does. Hence, to assign acceptability ratings to comparative constructions, speakers must be able to count and add the dimensions of these conceptual categories.

In a similar vein, as these statements contain instances of nouns that are characterized by partial and unequal category membership (to be healthy in some respects but not necessarily in others, to be healthier than someone else), these structures are predicted to be sensitive to the gradedness levels (Estes 2003, 2004) of the concept used as predicate. Consequently, acceptability ratings of dimension-counting structures that feature ungraded categories, which do not permit dimension counting, is predicted to be lower as compared with graded concepts which permit counting-based classification. Hence, with nouns, quantificational and comparative structures are predicted to be rated higher with artefactual categories as compared to biological categories.

Our study asks two questions:

(i) a. Can acceptability ratings of dimension-counting constructions be used as diagnostics of the domain effects on categorization observed by Estes (2003,2004) and Hampton et al. (2009)?

b. Would artifacts and social categories demonstrate a similar pattern, as predicted by Hampton et al. (2009)?

(ii) Would these ratings pattern differently with adjectives?

If dimension-counting constructions with nominal artefactual concepts will be rated as significantly more acceptable then with nominal biological concepts, reflecting the domain differences previously observed in the literature, then the answer to (i) would be yes. Such a result would enable addressing (ii) by using these configurations as diagnostics of discrete dimension accessibility in adjectives. Moreover, it would add a new, simple and straightforward measure for conceptual gradedness, which could be highly instrumental for future research on conceptual representation.

If, instead, the answer to (i) would be no, it would suggest, in line with linguistic models of quantifications and comparisons constructions (Hackl, 2001; Kennedy & McNally, 2005; Rett, 2013; Rotstein & Winter, 2004; Schwarzschild, 2006; Solt, 2009, a.o.), that the possibility to occur in these constructions depends mainly on the structural semantic and syntactic properties of a lexical item, rather than representational properties of the concept it denotes.

If domain effects will be observed in nominal dimension-counting constructions, but not in adjectival ones, the answer to (ii) will be yes. This would support an underlying conceptual distinction for lexical categories, promoted by conceptual models for lexical categorization.

As mentioned, we adopted the design used in Sassoon and Fadlon (2017). In their study, English speakers were asked to rate classification, quantificational and comparative nominal and adjectival structures. Conceptual domain was manipulated across lexical category and structure, such that the subjects of this structures were either biological (e.g. *robin, oak*) or artefactual and social (e.g. *hammer, philosopher*). The latter two were treated as one class, based on Hampton et al.'s (2009) prediction that social categories will pattern like artifacts. The predicates were either nouns belonging to the same domain as the subject (*This robin is a bird*/*This chair is a piece of furniture*) or adjectives appropriate for their description (*This bird is energetic*/*This chair is fashionable*) (see demonstration in table 1).

Their findings indicate that across the domain manipulation, adjectival dimension-counting structures are rated higher than nominal ones and that domain manipulation modulated the naturalness of nominal dimension-counting structures (artifact & social>biological), but not the naturalness of adjectival ones.

However, there are some flaws in the stimuli selection procedure implemented in that study. Most of the nominal items used in it were taken from the stimuli reported in Hampton et al. (2009) with human traits and professions chosen from a list created by searching COCA (Davies 2010) for the string “(s)he is a” followed by a noun. Adjectives, on the other hand, were chosen from a list of multidimensional adjectives, created by searching for "more adjective and adjective”. First, the fact that the search for nominal concepts used a simple classification structure while the search for adjectival concepts used a comparative structure might explain the interaction between lexical category and structure. Second we believe that in order to demonstrate that domain effects in nouns are a general phenomenon, it is important to examine concepts that were not previously tested. Our study addressed these concerns by employing a random stimuli selection procedure. In addition, as we elaborate below, in the current study frequency of occurrence, length and level of conceptual abstraction were counterbalanced between conditions.

Finally, an additional potentially confounding factor was avoided in the current study by targeting Hebrew rather than English. In English, some adjectives can combine with both free and bound comparison morphemes (e.g. *safer*, *more safe*). As a result, in Sassoon and Fadlon’s materials, comparative adjectival structures were formed using both free and bound comparative morphemes, whereas comparative nominal structures were all formed with free comparative morphemes. This resulted in a lack of structural uniformity within the set of adjectival comparisons and between adjectival and nominal comparisons. Since in Hebrew comparison structures can only be formed using free morphemes, the current study managed to avoid this confound.

Like Sassoon and Fadlon (2017), the study reported below contrasted biological categories with artifacts and social categories. Below, we also provide a further post-hoc analysis comparing ratings of dimension-counting constructions with artifacts to social nouns, hence providing an answer to question (i)b presented above, concerning Hampton et al.'s prediction that these two domain should demonstrate similar patterns.

Experiment

Participants

42 adult native Hebrew speakers (25 female, ages 23-45, mean age 26.9) participated in this study. All participants were students recruited online and via ads and paid a fee of 25 NIS (approximately five USD). None had any education relevant to the subject matter of the study.

Methods

Materials

Our stimuli consisted of 192 sentential items: 144 experimental and 48 controls.

To create our experimental items, the following three factors were fully crossed:

1. **Structure**: our stimuli included three types of structures: (1) comparisons (2) existential quantifications (3) simple classifications used as baseline (see set example in table 1).
2. **Predicate type**: predicates were either nouns or adjectives
3. **Domain**:

a. Nominal predicates and subject nouns either denoted biological concepts or artefactual and social concepts

b. Adjectival predicates were chosen such that they can describe a given subject-noun (the selection process is reported immediately below).

<TABLE 1 HERE>

Nominal predicates, subject-nouns and adjectival predicates (provided in appendix A) were selected randomly using the following method:

1. Lists of nouns of the following biological and artefactual and social categories were generated via Google searches of the strings ‘list of types of ___” (in Hebrew), and using the category-search option in the Hebrew version of Wikipedia:

(a) Biological: *fruit, vegetable, flower, bird, insect, predator, mammal, pet, fish, reptile, tree, plant, rock, bush.*

(b) Artefactual and social : *lecturer, artist, vehicle, container, furniture, periodical, building, musical instrument, tool, clothing, doctor, profession, jewellery, accessory, game, weapon, vessel, sauce, drink, toy, salad, soup.*

After we removed items that are unfamiliar to non-specialists, these lists consisted of over 600 items.

2. 12 biological 12 artefactual and social items were then randomly selected to occupy the predicate positions in our nominal conditions.

3. For each nominal predicate, a noun that denotes a less specific category (e.g. dandelion → flower) was chosen to occupy the subject position. In sum, there were 24 subject-nouns.

4. A list of over 300 positive multidimensional adjectives was categorized according to the types of entities they describe (*people, animals, places, food, artifact, or plants*). For each subject-noun, one adjectival predicate was randomly chosen from the relevant list. Accordingly, 12 adjectives described biological subjects and 12 described artefactual and social subjects.

This process was repeated until subject-nouns and predicates were matched with regard to frequency of occurrence[2] and length (by characters, words, morphemes and syllables) between domains and lexical categories.

Finally, subject nouns and nominal predicates were counterbalanced for level of abstraction (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Rosch, 1978), i.e. the number of specific categories (*dandelion*, *rocking-chair*), baseline level categories (*flower*, *chair*) and superordinate categories (*plant*, *furniture*).

Our stimuli also included three types of control items:

1. Quantifications with dimensional adjectives (*This station is open in some respect)*. We predicted these quantifications to receive low ratings since they embed a category that fails to have multiple dimensions under a dimension-counting structure.

2. Comparisons with adjectives under which classification is not a matter of degree (*meteorological*, *atomic*), which we term *non-dimensional* (*This station is more meteorological than that station*). We predicted these comparisons to receive low ratings since they compare two objects with regard to the degree to which they exemplify a non-gradable category.

3. Our 24 experimental subject-nouns with their nominal predicates in a 'midget'-modification structure (*this is a midget tree/chair)*. If lower ratings for biological nouns in

dimension-counting structures are due to a structural restriction preventing them from being embedded under a modifier, as opposed to properties of the corresponding concept, it is predicted that they will also be rated lower than social nouns in 'midget' structures. In contrast, a difference in the effects of the entity manipulation in dimension-counting vs. 'midget' structures would suggest that ratings for the former are not due to structural restrictions.

A full list of the subject nouns and predicates used to create the control items can be found in appendix B.

*Pretest: copula inclusion***.** In Hebrew, classifications can either include or not include a verbal copula inflected for tense, person, number, and gender (e.g. present, 3rd person, singular: *hu*/*hi* ‘is-male/is-female’; past, 3rd person, singular: *haya*/*hayta* ‘was-male/was-female’). Intuitively, classifications with nouns are more natural with a copula while classifications with adjectives are more natural without one**.** To test this, we ran a copula inclusion pretest, in which native speakers were asked to choose the more natural statement out of copula/no-copula pairs. The results confirmed our intuition. There was a very strong main effect for lexical category ($F(1,52) = 1710$, $p < 0.001$), with 85% of copula-statement choices for the nouns and only 0.7% copula-statement choices for adjectives. Accordingly, in our experiment all nominal items included a copula and all adjectival statements did not.

Design and Procedure

A Latin square design assigned materials to two lists, such that participants encountered only the adjectival or the nominal version of an item. In sum, each participant encountered 72 experimental items and 48 controls presented in a fully randomized order.

The experiment was programmed using Linger (Doug Rohde, 2003). Items were presented in a self-paced reading paradigm, such that the previous and following words of the sentence were masked by dashes. This was done to minimize introspection on test items (as suggested in Hofmeister & Norcliffe, 2013) by promising incremental processing in which going back to a previously processed part is impossible.[3] After the commencement of each item, dashes were replaced by a seven point acceptability (naturalness) scale, headed by the instruction "how natural was that sentence?" with the tags "not natural at all" next to the lowest rating (1) and "completely natural" next to the highest rating (7). Participants were examined individually in a quiet room. They received a short explanation regarding the manner each item would be presented and were instructed to read each sentence in natural pace while making sure they comprehend its contents. Before they began the experiment, participants underwent a practice block of three items. Breaks were set such that participants completed 3 sequences of 40 items intervals, separated by short breaks. The durations of these breaks were controlled by the participant.

Results

Mean naturalness ratings and standard deviations are presented in table 2 below, for mean ratings by predicate see appendix C:

<TABLE 2 HERE>

The Overall Model

We fitted mixed effects regression models for our data, with z scores of naturalness ratings as the dependent variable and participants and items as random effects.

Our first regression defined the three manipulated factors as fixed factors and was applied on the entire set of experimental observations. The converging model included random intercepts and random slopes of our fixed effects for subjects and items. This yielded significant main effects of structure ($F(2, 60.11) = 153.662$, $p < .001$), domain ($F(1, 67.22) = 22.7$ $p < .001$, artefactual & social > biological) and predicate type ($F(1, 65.26) = 298.56$, $p < .001$, adjectival > nominal items). Further, this analysis yielded significant interactions between structure and predicate type ($F(2, 62.88) = 244.51$, $p < .001$), structure and domain ($F(2, 42.82) = 9.58$, $p < .001$) and predicate type and domain ($F(1, 62.83) = 17.9$, $p < .001$), as well as a three-way interaction ($F(2, 62.85) = 10.8$, $p < .001$).

Predicate type × Domain × Structure

The significant three-way interaction reported above indicates that the naturalness of a conceptual category in a dimension-counting construction as compared to a baseline classification is modulated by both lexical category and domain. To reveal the source of this interaction, we divided our experimental materials by predicate type and fitted follow-up mixed model regressions to each.

Structure and domain in nouns. The converging model included random intercepts for items and subjects. It yielded significant main effects of structure ($F(2,65.66) = 597.29$,

$p < .001$) and domain ($F(1,65.53) = 47.73$, $p < .001$) and a significant interaction ($F(2,65.56) = 14.97$, $p < .001$).

Planned comparisons with an application of a Bonferroni correction (×9[4]) revealed that, as shown in table 3 and demonstrated in figure 1, for both domains, baseline classifications were rated significantly higher than comparative (rows 1 and 4) and quantificational structures (rows 2 and 5). Within each structure, ratings of biological baseline classifications were not significantly different from ratings of artefactual and social ones (row 7), but artefactual and social comparative and quantificational constructions were rated significantly higher than biological comparative and quantificational constructions, respectively (rows 8-9).

<TABLE 3 HERE>

<FIGURE 1 HERE>

Structure and domain in adjectives. The converging model included random intercepts for items and subjects and yielded a significant main effect of structure ($F(2,65.66) = 597.29$, $p < .001$).

Planned comparisons (Bonferroni ×9) revealed that, as shown in table 4 and demonstrated in figure 2, for both types of entities, ratings of simple classifications were not significantly different than ratings of comparative constructions (rows 1 and 4) but were significantly higher than ratings of quantificational constructions (rows 2 and 5). Further, quantificational constructions were also rated lower than comparative ones (rows 3 and 6). Importantly, within structure comparisons revealed that the adjectival data set patterned differently than the nominal one: ratings of biological and artefactual and social items were not significantly different (rows 7,8 and 9).

<TABLE 4 HERE>

<FIGURE 2 HERE>

Further planned comparisons are reported in appendix D.

Control Items

We fitted two additional regressions for the entire nominal data set and the entire adjectival data set. The converging regression for the adjectival experimental and control items included domain and condition (baseline/quantification/comparison/control-quantification/control-comparison) as fixed factors and random intercepts for subjects and items.

As shown in table 5 below, planned comparisons revealed that comparisons with non-gradable adjectives were rated significantly lower than our experimental adjectival comparisons (row 1). Similarly, quantifications with one-dimensional adjectives were rated significantly lower than experimental adjectival quantifications (row 2).

The converging nominal regression included domain and condition (baseline classification/comparison/quantification/midget) as fixed factors, random intercepts for subjects and items and random slopes of structure for subjects and domain for items. Pairwise comparisons revealed that biological midget items (M = 5.26, SD = 2.08) were rated significantly higher than artefactual and social ones (M = 2.82, SD = 2) (row 3).

<TABLE 5 HERE>

Do Artefactual and Social Categories Pattern the Same?

Based on previous literature (e.g., Hampton et al., 2009; Sassoon & Fadlon, 2017), we grouped artifacts and social nouns together. The analyses presented above demonstrate that ratings of dimension-counting constructions with biological nominal predicates pattern differently than those of dimension-counting constructions with a class of predicates consisting of both artifacts and social nouns. As this contrast is replicated across several statistical analyses, it appears that the latter class demonstrate uniform behavior. This is confirmed by the distribution of average ratings across these two domain as demonstrated in figure 3.

<FIGURE 3 HERE>

To verify, we fitted an additional mixed-model regression on z-score data from artefactual and social items, with structure, sub-domain (artefactual/social) and predicate type (nominal/adjectival) as fixed factor and subject and items and their related slopes as random effects. The converged model did not include the interactions between random slopes.

This yielded a significant effect of structure ($F(2,33.94) = 87.5$, $p < .001$) and predicate type ($F(1,47.14) = 145.6$, $p < .001$) and a significant interaction between them ($F(2,30.4) = 91.77$, $p < .001$). As expected, we were unable to identify a main effect of sub-domain or any related interaction (*ps* > .15).

Discussion

The results of our experiment reveal conceptual domain differences in the naturalness of dimension-counting constructions featuring conceptual categories corresponding to nouns and hence corroborate the interpretation of domain effects previously observed in English (Estes, 2003, 2004; Hampton et al., 2009; Sassoon & Fadlon 2017). This indicates general conceptual patterns. Ratings of both comparative and quantificational structures were significantly higher when they involved artefactual and social nominal categories than when they involved biological nominal categories. A further analysis failed to find a difference between artefactual and social nouns, hence further supporting Hampton et al.'s (2009) prediction that the classification strategy in artefactual and social nouns is similar, i.e. based on additive calculation. This consistency indicates that naturalness ratings of dimension-counting constructions are indeed reliable diagnostics for detecting domain effects, namely the gradedness and additivity associated with artefactual and social categories and its absent from biological ones. As mentioned, we suggested that both properties are related to discrete dimension accessibility: a property that allows choosing a subset of category-defining dimensions as well as counting them.

In contrast, the domain manipulation did not modulate the naturalness ratings of adjectival dimension-counting constructions. Even though no significant difference was observed between nominal and adjectival baseline classifications, adjectival quantificational and comparative constructions were rated significantly higher (with a lowest rating of 4.54 for quantifications) than their nominal counterparts.

The data obtained from our control items indicate that this contrast is due to conceptual category structure as opposed to being dependent on lexical category alone. Dimension-counting constructions with one-dimensional and non-dimensional adjectives were rated lower than dimension-counting constructions with multidimensional adjectives. This contrast cannot be explained if the naturalness of this structure is related to lexical category of the predicate alone. Further, in midget constructions, biological nominal items were rated significantly higher than social nominal predicates. As this domain effect is the mirror image of the one observed with nominal dimension-counting constructions, it demonstrates that the latter cannot be viewed as a result of reduced naturalness ratings for biological nominal classification embedded under a modifier. If that were the case, midget and dimension-counting constructions would have patterned the same. This contrast hence confirms our assumption that the reduced naturalness of biological nominal predicates embedded under quantifications and comparisons is related to the dimension-counting aspect of their interpretation, as opposed to a restriction on embedding biological nouns under a modifier.

We take our findings to suggest that conceptual categories corresponding to adjectives are inherently additive and exhibit high levels of gradedness. Using the term we adopted in this paper, we hence conclude that in conceptual categories corresponding to nouns dimension accessibility is modulated by domain, whereas in those corresponding to adjectives this property is always available.

Our results further suggest that distribution in these structures is also highly sensitive to conceptual distinctions. This contrasts with many semantic analyses of quantifications and comparisons that discuss the ways in which the possibility to occur in these constructions is modulated by their structural semantics and the syntactic properties of a lexical item

(Hackl, 2001; Kennedy & McNally, 2005; Rett, 2013; Rotstein & Winter, 2004; Schwarzschild, 2006; Solt, 2009, a.o.).

Finally, our findings indicate that studies targeting classification should address or at least control lexical category in general, and, in particular the noun/adjective distinction, given that multidimensional concepts can be encoded as either nouns or adjectives. As we mention above, previous studies have either ignored this distinction or were confounded by it.

Implications for Models of Lexical Categorization

In the context of lexical categorization, the conceptual distinction we observed suggests that an accurate theory about parts of speech should consider the conceptual properties of the entities they denote. This means that our findings provide further support for considering conceptual representation consistencies in models of the nouns/adjective distinction. In what follows, we propose ways in which conceptual models can capture the representational distinction we observed.

Let us start with models that assume parts of speech continuums. Given our observation that discrete dimension accessibility is an inherent property of multidimensional concepts manifested as adjectives in Hebrew as well as in English, we propose that nouns that exhibit this property may be represented closer to the middle of the noun-adjective-verb continuum than the ‘nouniest’ nouns would. Naturally, as parts of speech continuum models rely on cross-linguistic data, further typological evidence is needed to justify this stipulation.

In a similar vein, Croft's (2001) conceptual space could map biological nouns to the most prototypical class for the discourse function 'reference' (object) and artefactual and social nouns to a less prototypical class for this function (e.g. property), which is closer to the area into which it would map adjectives. Notice, however, that our study does not provide insight into the dimension accessibility of less prototypical nouns, like the ones denoting abstract concepts, such as *joy* or *emotion*. This is also true with regard to less prototypical noun-derived adjectives, such as *birdy* or *doctory*.

Lastly, let us discuss conceptual views that assume a more categorical distinction between nouns and adjectives, namely the object-category/property distinction, which is also prevalent in studies on conceptual developments (Booth & Waxman 2009; Hall & Moore, 1997; Waxman & Markow, 1998, a.o.). As mentioned, we believe that, given that many adjectives denote *multiple* properties, this distinction cannot be motivated by attributing *multiple* properties to nouns and *single* properties to adjectives as proposed by Jespersen (1924), Bolinger (1967, 1980), and Wierzbicka (1980, 1986).

In addition, although we are not aware of literature which addresses the basis for the intuitive view that nouns categorize objects and adjectives assign them with properties advanced by these models, we believe it originates from the fact that, as we note above, many adjectives are context dependent (Kennedy, 2007; Klein, 1980; Schwarzschild, 2006; McNally & Stojanovic, 2015 ; Solt, in progress, a.o.). This means that denotation of a given adjective is sensitive to the conceptual category of the entity that is being classified (*this bird/child is healthy*) or modified (*a healthy bird/child*). The internal structure of conceptual categories corresponding to nouns, on the other hand, i.e. object-categories, naturally correlates with the domain of the entities they themselves denote. From this, the assumption that adjectives are properties whereas nouns are categories comes naturally.

Let us assume then, that the main motivation for category/property models of the noun/adjective distinction is the fact that categorization under adjectives is sensitive to context. If this is the case, then our findings that in multidimensional adjectives, but not in nouns, discrete dimension accessibility is an inherent property, is in natural accordance with this view. If viewing adjectives as 'properties' is based on their sensitivity to context, it naturally follows that speakers are rather freely able to choose a subset of contextually relevant dimensions of a given adjective, hence that their dimensions exhibit discrete dimension accessibility. In sum then, although the finer details of such a view are subject for future work, our findings appear to also be consistent with the object/property distinction.

Conclusion

Our study of Hebrew compared the naturalness of dimension-counting constructions embedding classification statements with artefactual and social vs. biological nouns and multidimensional adjectives. Based on the compositional semantics of these structures and the results of a previous experiment targeting English speakers (Sassoon & Fadlon, 2017) we predicted that acceptability in these constructions would reflect conceptual additivity and gradedness. Our study of Hebrew, designed to avoid methodological shortcomings we identified in Sassoon and Fadlon (2017), replicated its observation that in nouns, biological predicates are rated significantly lower than artefactual and social predicates in these constructions, whereas in multidimensional adjectives, the conceptual domain manipulation did not predict acceptability, which remained relatively high across the domain manipulation.

Given that the performance pattern we observed with nouns is consistent with the findings of previous studies on conceptual domain effects in nominal concepts, which employed different methods than the one used in the current experiment (Estes, 2003, 2004; Hampton et al., 2009), we suggested that acceptability in dimension-counting constructions can indeed be used as a diagnostic of conceptual additivity and gradedness. Based on this conclusion, we proposed that conceptual categories corresponding to adjectives are inherently additive and graded, properties we view as related to discrete dimension accessibility. Finally, we have taken this interaction between domain and lexical category as indicating that the latter is not to be overlooked in studies on classification and discussed the implications of our findings on models of lexical categorization. Specifically, we suggested that parts of speech continuum models could add discrete dimension accessibility as a criterion for representation away from the nominal edge and demonstrated it is consistent with object-category/property models.

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Appendix A

Subject Nouns and Predicates Used in the Experimental Conditions

Biological (6 plant, 6 animal)					
Subject		**Nominal predicate**		**Adjectival predicate**[1]	
‘ec	‘tree’	*škediya*	‘almond-tree’ (one word)	*maršim*	‘impressive’
pri	‘fruit’	*pomelit*	‘pomelo-grapefruit hybrid’ (one word)	*na’e*	‘nice’ (synonym)
yerek	‘vegetable’	*xasa-‘agula*	‘round lettuce’	*ekzoti*	‘exotic’
si'ax	‘bush’	*‘ezovyon*	‘lavender’	*mele-xa’im*	‘lively’ (two words)
cemax	‘plant’	*‘afuna*	‘pea’	*metupax*	‘well-kept’ (1word)
perax	‘flower’	*šošana*	‘rose’ (non metaphorical)	*‘esteti*	‘aesthetic’
xaya	‘animal’	*‘ayala*	‘doe’	*atraktivit*	‘attractive’
cipor	‘bird’	*šaxrur*	‘blackbird’	*xinanit*	‘graceful’
yonek	‘mammal’	*‘arnevet*	‘rabbit’	*‘aktivi*	‘active’
xarak	‘insect’	*zvuvon*	‘fly’ (diminutive)	*zariz*	‘agile’
toref	‘predator’	*‘arye*	‘lion’	*‘amic*	‘courageous’
zoxel	‘reptile’	*cav*	‘turtle’	*mistori*	‘mysterious’

[1] Note that many of the multidimensional adjectives used also belong to a set characterized as 'evaluative', which tend to describe a person’s behavior or attitude in terms of subjective judgment (Landau, 2006, see also Barker, 2002; Stowell, 1991). This is not surprising given that classification that is sensitive to multiple dimension would inevitably lead to higher levels of contextual variance, manifested in higher acceptance levels of faultless disagreement (McNally & Stojanovic, 2015; Solt in progress), i.e. subjectivity.

Social and artefactual (6 human traits, 6 artifacts)					
Subject		**Nominal predicate**		**Adjectival predicate**	
xoker	‘researcher’	*biyolog*	‘biologist’	*macli’ax*	‘successful’
mumxe	‘specialist’	*mišpatan*	‘lawyer’	*šarmanti*	‘charming’
rofe	‘doctor’	*genikolog*	‘gynecologist’	*canu’a*	‘modest’
menate'ax	‘surgeon’	*noyrolog*	‘neurologist’	*meheyman*	‘reliable’
metapel	‘therapist’	*dietan*	‘dietitian’	*hogen*	‘fair’
šutaf	‘partner’	*balaš*	‘detective’	*‘ixpati*	‘caring’
rahit	‘furniture’	*mexica*	‘partition’	*šimuši*	‘useful’
kise	‘chair’	*šrafraf*	‘stool’	*melutaš*	‘polished’
meyxal	‘container’	*paxit*	‘can’	*takin*	‘functioning’
kli	‘dish’	*ke’arit*	‘bowl’	*pašut*	‘simple’
binyan	‘building’	*migdal*	‘tower’	*me’ucav*	‘well-designed’ (one word)
beged	‘piece of clothing’ (1 word*)*	*xulca*	‘shirt’	*prakti*	‘practical’

Appendix B

Subject Nouns and Predicates Used in Control Conditions 1 and 2

Subject		***Non-dimensional***		***Dimensional***	
mapa	‘map’	*kalkalit*	‘economical’	*retuva*	‘wet’
mispar	‘number’	*rišoni*	‘prime’ (adjective)	*kiconi*	‘extreme’
gan	‘garden’	*botani*	‘botanical’	*mu’ar*	‘bright’
gan-xayot	‘zoo’	*tanaxi*	‘biblical’	*metukcav*	‘budgeted’
nitu’ax	‘surgery’	*keysari*	‘cesarean’	*kcarcar*	‘very short’
xoreš	‘forest’	*atlanti*	‘atlantic’	*‘avot*	‘dense’
šetax	‘area’	*yami*	‘maritime’	*harari*	‘hilly’
sargel	‘ruler’	*metri*	‘metric’	*matxti*	‘metallic’
do’ar	‘mail’	*electroni*	‘electronic’	*tadir*	‘frequent’
til	‘missile’	*atomi*	‘atomic’	*šakuf*	‘transparent’
taxana	‘station’	*mete’orologit*	‘meteorological’	*ptuxa*	‘open’
yesod	‘element’	*ximi*	‘chemical’	*tahor*	‘pure’

Appendix C

Mean ratings by predicate

Nominal

Subject -noun		**Predicate**		**Baseline**	**Comparison**	**Quantification**
‘ec	‘tree’	*škediya*	‘almond-tree’ (one word)	7.0	2.1	2.0
pri	‘fruit’	*pomelit*	‘pomelo-grapefruit hybrid’ (one word)	6.9	2.5	2.2
yerek	‘vegetable’	*xasa-‘agula*	‘round lettuce’	6.5	2.0	2.0
si'ax	‘bush’	*‘ezovyon*	‘lavender’	6.9	2.5	2.4
cemax	‘plant’	*‘afuna*	‘pea’	6.7	2.2	2.5
perax	‘flower’	*šošana*	‘rose’ (non metaphorical)	6.9	2.7	2.5
xaya	‘animal’	*‘ayala*	‘doe’	7.0	2.0	2.3
cipor	‘bird’	*šaxrur*	‘blackbird’	6.5	1.9	2.4
yonek	‘mammal’	*‘arnevet*	‘rabbit’	6.0	1.8	2.2
xarak	‘insect’	*zvuvon*	‘fly’ (diminutive)	6.9	2.8	3.1
toref	‘predator’	*‘arye*	‘lion’	6.8	1.8	2.1
zoxel	‘reptile’	*cav*	‘turtle’	6.2	2.7	2.6
xoker	‘researcher’	*biyolog*	‘biologist’	6.9	4.5	3.8
mumxe	‘specialist’	*mišpatan*	‘lawyer’	6.8	4.1	3.5
rofe	‘doctor’	*genicolog*	‘gynecologist’	7.0	3.2	2.9
menate'ax	‘surgeon’	*noyrolog*	‘neurologist’	6.8	3.0	2.7
metapel	‘therapist’	*dietan*	‘dietitian’	6.8	3.5	3.4
šutaf	‘partner’	*balaš*	‘detective’	6.1	3.4	3.5
rahit	‘furniture’	*mexica*	‘partition’	6.5	3.1	4.2
kise	‘chair’	*šrafraf*	‘stool’	6.0	3.4	3.3
meyxal	‘container’	*paxit*	‘can’	6.8	2.6	2.8
kli	‘dish’	*ke’arit*	‘bowl’	6.5	3.9	3.9
binyan	‘building’	*migdal*	‘tower’	6.7	4.2	4.0
beged	‘piece of clothing’ (1 word)	*xulca*	‘shirt’	6.6	2.3	2.7

Adjectival

Subject -noun		**Predicate**		**Baseline**	**Comparison**	**Quantification**
'ec	'tree'	*maršim*	'impressive'	7.0	6.9	5.2
pri	'fruit'	*na'e*	'nice' (synonym)	5.8	5.6	4.8
yerek	'vegetable'	*ekzoti*	'exotic'	6.7	6.6	4.9
si'ax	'bush'	*mele-xa'im*	'lively' (two words)	6.3	5.8	4.7
cemax	'plant'	*metupax*	'well-kept' (1word)	6.7	7.0	4.0
perax	'flower'	*'esteti*	'aesthetic'	6.6	6.3	4.9
xaya	'animal'	*atraktivit*	'attractive'	6.2	6.2	4.9
cipor	'bird'	*xinanit*	'graceful'	6.7	6.4	5.1
yonek	'mammal'	*'activi*	'active'	6.4	6.6	5.0
xarak	'insect'	*zariz*	'agile'	7.0	7.0	4.1
toref	'predator'	*'amic*	'courageous'	6.5	6.6	4.4
zoxel	'reptile'	*mistori*	'mysterious'	5.9	5.2	5.3
xoker	'researcher'	*macli'ax*	'successful'	6.8	6.8	5.0
mumxe	'specialist'	*šarmanti*	'charming'	6.9	6.4	4.6
rofe	'doctor'	*canu'a*	'modest'	6.9	7.0	4.9
menate'ax	'surgeon'	*meheyman*	'reliable'	6.7	6.9	3.8
metapel	'therapist'	*hogen*	'fair'	6.8	7.0	4.8
šutaf	'partner'	*'ixpati*	'caring'	7.0	7.0	5.3
rahit	'furniture'	*šimuši*	'useful'	6.9	7.0	5.2
kise	'chair'	*melutaš*	'polished'	6.3	6.8	3.4
meyxal	'container'	*takin*	'functioning'	7.0	6.3	3.5
kli	'dish'	*pašut*	'simple'	6.1	6.7	4.9
binyan	'building'	*me'ucav*	'well-designed' (one word)	6.6	6.7	4.1
beged	'piece of clothing' (1 word)	*prakti*	'practical'	6.5	6.6	5.0

Appendix D

Main Effect of Structure and Two-Way Interactions

To reveal the sources of the main effect of structure and the two-way interactions observed under the overall model, we ran planned pairwise comparisons with an application of a Bonferroni correction for multiple comparisons (×14).

Structure

Simple classifications were rated significantly higher than comparative constructions (Est. = .9, SE =.05 , $t(60.7) = 16.3$, $p < .001$) and quantificational construction (Est. = 1.3 , SE = .088, $t(56.3) = 14.41$, $p < .001$) . A comparison of comparative and quantificational constructions revealed that, overall, the former were rated significantly higher than the later (Est. = .4 , SE = .077 , t(61.8) = 5.46 , $p < .001$)

Structure ×Predicate

Across domains, with adjectives, ratings of simple classifications were not significantly different than ratings of comparative structures (Est. = .0, SE = .063, $t(60.3) = .48$, $p = .63$, uncorrected) but were significantly higher than ratings of quantificational structures (Est. = .9, SE =.09 , $t(70.5) = 8.97$, $p < .001$). Further, adjectival quantifications were rated significantly higher than comparisons (Est. = .8, SE =.08 , $t(81.9) = 10.22$, $p < .001$).

With nouns, overall ratings of simple classifications were significantly higher than ratings of comparative structures (Est. = 1.7, SE = .063, $t(61.6) = 25.05$, $p < .001$) and ratings of quantificational structures (Est. = 1.7, SE =.096 , $t(63.9) = 17.54$, $p < .001$). Ratings of comparative and quantificational constructions were not significantly different

(Est. = .0, SE =.084 , *t*(78.3) = -.4 , *p* = .7, uncorrected).

Further, while the ratings of nominal baseline classifications were not significantly different than those of adjectival baseline classifications (Est. = .0, SE =.064 , *t*(89.2) = .25 , *p* = .8, uncorrected), the ratings of nominal comparative and quantificational constructions were significantly lower than the ratings of their adjectival counterparts (quantifications: Est. = -.8, SE =.064 , *t*(88.3) = -12.39 , p < .001; comparisons: Est. = -1.7, SE =.065 , *t*(89.2) = -25.85 , *p* < .001).

Structure ×Domain

Across predicate types, biological baseline classifications were not rated significantly different than social baseline classifications (Est. = .0, SE = .05 , *t*(28.5) = -.63 , *p* = .54, uncorrected). Similarly, biological quantificational constructions were not rated significantly different than social quantificational constructions (Est. = -.2, SE = .073 , *t*(32.2) = -2.4 , *p* = .28). Ratings of biological comparative constructions were however significantly lower than ratings of social comparative constructions (Est. = -.4, SE = .057, *t*(41.5) = -6.32 , *p* < .001).

Predicate type × Domain

Across structures, nominal biological constructions were rated significantly lower than social constructions (Est. = -.3, SE = .051, *t*(68.3) = -6.24 , *p* < .001), whereas for adjectives, ratings of biological constructions were not significantly different than those of social constructions (Est. = -.1, SE = .05 , *t*(80.6) = -1.18 , *p* = .24, uncorrected).

Footnotes

[1] Importantly, note that our use of the term ‘accessibility" shouldn’t be taken as entailing an argument about the processing mechanisms underlying classification decisions, as these are beyond the scope of the current paper.

[2] Frequency of occurrence was drawn from the “all literature” corpus http://hebrewcorpus.nmelrc.org/.

[3] Note that although this design is typically used to detect online effects by measuring differences in reading times of critical words, the current study was not designed as a reading times study. As a result, it contains structural imbalance, which renders reading times data invalid.

[4] We applied a Bonferroni correction according to the number of comparisons performed under each model. Where uncorrected *p*-values were already quite high, we report the original values followed by the notation ‘uncorrected’.

Table 1

Set example

Biological

Nominal baseline	*Ha-yonek ha-ze hu ʻarnav* the-mammal the-it is rabbit 'This mammal is a rabbit.'
Nominal comparison	*ha- yonek ha-ze hu yoter arnav me-ha-yonek ha-hu* the-mammal the-it is more rabbit than-the-mammal the-him 'This mammal is more rabbit than that mammal.'
Nominal quantification	*ha-yonek ha-ze hu arnav me-eyzošehi bxina* the-mammal the-it is rabbit from-some respect 'This mammal is a rabbit in some respect.'
Adjectival baseline	*ha-yonek ha-ze aktivi* the-mammal the-it active 'This mammal is active.'
Adjectival comparison	*ha-yonek ha-ze yoter ʻaktivi me-ha-yonek ha-hu* the-mammal the-it more active from-the-mammal the-him 'This mammal is more active than that mammal.'
Adjectival quantification	*ha-yonek ha-ze ʻaktivi me-eyzošehi bxina* the-mammal the-it active from-some respect 'This mammal is active in some respect.'

Artefactual and Social

Nominal baseline	*ha-beged ha-ze hu xulca* the-piece-of-clothing the-it is shirt 'This piece of clothing is a shirt.'
Nominal comparison	*ha-beged ha-ze hu yoter xulca me-ha-beged ha-hu* the-piece-of-clothing the-it is more shirt than-the-piece-of-clothing the-him 'This piece of clothing is more shirt that that piece of clothing.'
Nominal quantification	*ha-beged ha-ze hu xulca me-eyzošehi bxina* the-piece-of-clothing the-it is shirt from-some respect 'This piece of clothing is a shirt in some respect.'
Adjectival baseline	*ha-beged ha-ze prakti* the-piece-of-clothing the-it practical 'This piece of clothing is practical.'
Adjectival comparison	*ha-beged ha-ze yoter prakti me-ha-beged ha-hu* the-piece-of-clothing the-it more practical than- the-piece-of-clothing the-him 'This piece of clothing is more practical than that piece of clothing.'
Adjectival quantification	*ha-beged ha-ze prakti me-eyzošehi bxina* the-piece-of-clothing the-it practical from-some-respect 'This piece of clothing is practical in some respect.'

Note. The decision to include a verbal copula (i.e. *hu/hi* ‘is male/female’) in nominal statements but not in adjectival statements was based on the results of a pre-test (see details in the experimental report).

Table 2

Mean Naturalness Ratings and Standard Deviation by Condition

	Baseline		Comparison (more)		Quantification (some)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Biological	**6.57**	**1.02**	**4.28**	**2.48**	**3.56**	**2.04**
Adjectival	6.48	1.00	6.33	1.25	4.77	1.84
Nominal	6.67	1.03	2.24	1.54	2.37	1.45
Artefactual & Social (A&S)	**6.66**	**0.89**	**5.08**	**2.22**	**3.96**	**1.94**
Adjectival	6.70	0.84	6.75	0.64	4.54	1.89
Nominal	6.61	0.93	3.42	1.98	3.38	1.82

Table 3

Pairwise Comparisons of Z-Scores, Nominal Data Set

		Est.	**SE**	**df**	***t***	**p**
1.	Biological: baseline – comp.	2	.078	65.9	25.84	< .001
2.	Biological: baseline – quant.	1.9	.078	65.3	24.58	< .001
3.	Biological: quant. –comp.	.1	.08	65.7	.94	.4 (uncorrected)
4.	A&S: baseline - comp.	1.4	.08	65.8	17.45	< .001
5.	A&S: baseline – quant.	1.4	.08	65.7	17.42	< .001
6.	A&S: comp. – quant.	.0	.07	64.4	.06	.9 (uncorrected)
7.	Baseline: A&S – biological	.0	.08	65.9	.44	.7 (uncorrected)
8.	Comparative: A&S – biological	.5	.08	65.9	6.71	< .001
9.	Quantificational: A&S - biological	.5	.08	65	5.73	< .001

Table 4

Pairwise Comparisons of Z-Scores of Adjectival Data Set

		Est.	**SE**	**df**	***t***	**p**
1.	Biological: baseline – comp.	.1	.08	65.8	.93	.35 (uncorrected)
2.	Biological: baseline – quant.	.8	.08	65.3	9.6	< .001
3.	Biological: comparative – quant.	.17	.08	65.9	8.48	< .001
4.	A&S: baseline – comp.	.0	.08	66.3	-.27	.79 (uncorrected)
5.	A&S: baseline – quant.	1	.08	66.1	11.54	< .001
6.	A&S: comp. – quant.	1	.08	65.4	12.11	< .001
7.	Baseline: A&S - biological	.1	.08	65.8	.93	.35 (uncorrected)
8.	Comparative: A&S - biological	.2	.08	66	2.29	.27
9.	Quantificational: A&S - biological	.1	.08	65.2	-1.32	.19 (uncorrected)

Table 5

Adjectival and Nominal Control Items

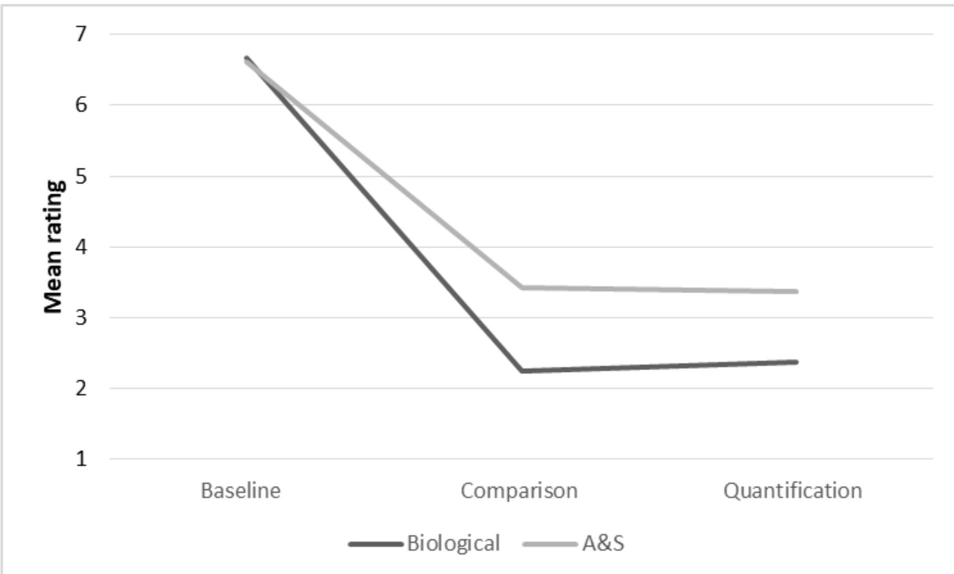
		Est.	**SE**	**df**	***t***	**p**
1.	Adjectival quantifications: MultiDim – Dim	1.5	.078	112.1	19.28	< .001
2.	Adjectival comparisons: MultiDim - NonDim	.5	.1	193.1	5.30	< .001
3.	Nominal: Midget Biological – Midget A&S	1.0	.072	53	14.28	< .001

Figure 1. Ratings of nominal items by structure and domain

Figure 2. Ratings of adjectival items by structure and domain

Figure 3. Rating of artefactual and social items by structure and predicate type

Figure 1


7
6
5
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1
Mean rating
Baseline
Comparison
Quantification
Biological
A&S

Figure 2

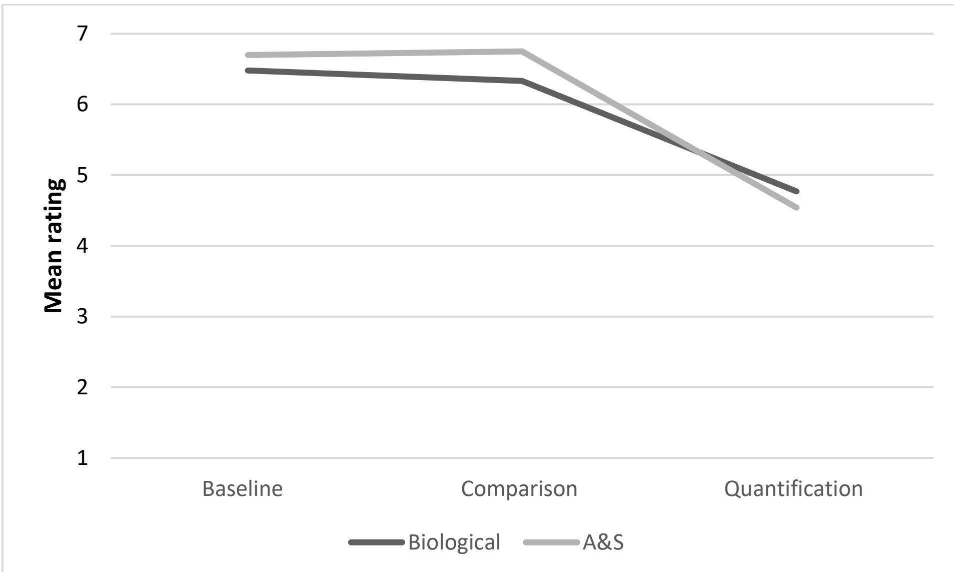
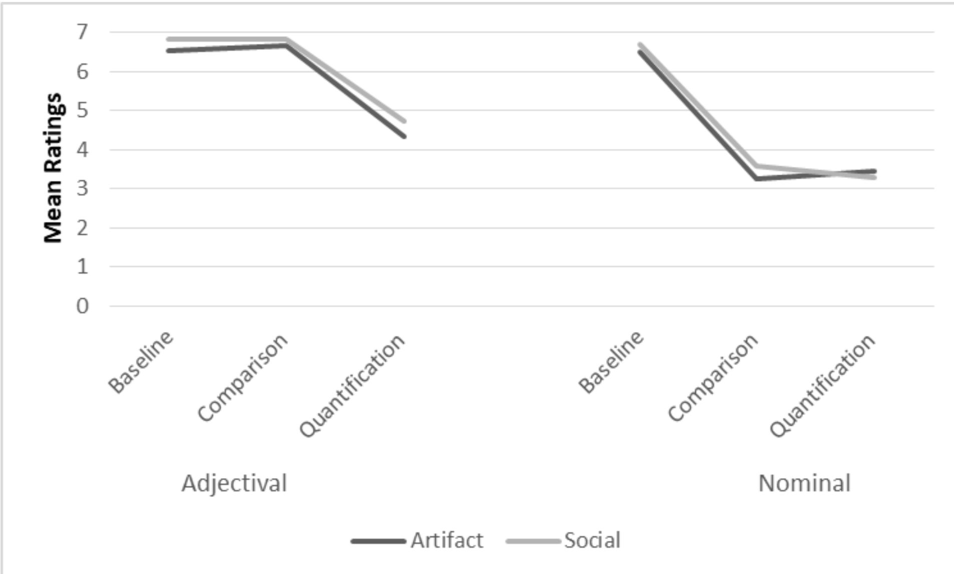


Figure 3


7
6
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Mean Ratings
Baseline
Comparison
Quantification
Baseline
Comparison
Quantification
Adjectival
Nominal
Artifact
Social