Dimension accessibility as a predictor of morphological gradability

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This paper presents a new approach to morphological gradability, which extends existing ones to cover manifestations of gradability in nouns and multidimensional adjectives. The approach correlates between the type of categorization criterion characteristic of a given noun or adjective and its acceptability with gradable morphemes like *more*. A preliminary experimental study is reported that confirms the predicted correlation, and concrete directions for future research are proposed.

Key words: Degree, Adjective, Noun, Comparison, Dimension, Similarity.

1. Adjectives vs. nouns in comparison constructions

Most adjectives, including, for example, *tall, expensive* and *healthy*, are *morphologically gradable*, meaning that they felicitously combine with degree morphemes, as in *taller, tallest, too tall, tall enough* and *very tall*. However, some adjectives exist that are not morphologically gradable, including, for instance, *geological, prime,* and *even*; e.g., a map can be said to be *more expensive* than another map, but not *more geological* than the latter.

Degree morphemes that classically combine with gradable adjectives are, by and large, incompatible with nouns, as the infelicitous forms in (1a) illustrate. The situation persists across languages (Baker 2003). For example, it prevails in Hebrew, even though Hebrew degree expressions are systematically free morphemes, as (1b) illustrates with the Hebrew equivalents of the examples in (1a). In particular, within noun comparisons such as the one in (2a) and its equivalent in (2b) are infelicitous.

(1) a. *#Ducker, #Duckest, #duck enough, #too duck, #very duck*
b. *#Yoter barvaz, Haxi barvaz, #Barvaz maspik, #Barvaz miday, #Meod barvaz*

(2) a. #The rightmost bird is more a duck than the leftmost bird.
b. #Ha-cipor ha-yemanit hi yoter barvaz me-ha-cipor ha-smalit

In English, for a within-noun comparison statement to be felicitous, the noun must occur as the complement of a mediating particle, such as the preposition *of* in (3a). In languages like Hebrew, an adjective such as *typical* must also occur, as in (3b). This adjective appears to have a dimension-set argument, which a noun phrase can saturate explicitly, as in *typical of a bird*, in which characteristics of birds serve as the dimensions of *typical* (Sassoon 2013a). Moreover, given nouns like *duck* as inputs, morpho-syntactic processes may yield adjective phrases as outputs, such as *duckish* or *duck-like.* An adjectival status goes along with a semantic shift toward interpretations compatible with degree morphemes, as illustrated in (3c).

(3) a. The rightmost bird is more **of** a duck than the leftmost bird.
b. Ha-cipor ha-yemanit hi yoter tipusit le-barvaz me-ha-cipor ha-smalit.
The rightmost bird is more **typical of** a duck than the leftmost bird.
c. This toy bird is more {duck**ish,** duck-**like}** than that toy bird.

Hence, generally, default literal interpretations of nouns are thought to be incompatible with the semantics of degree morphemes. This has led linguists to postulate a type difference (Kennedy 1999). Considering the basic types e for entities, d for degrees, and t for truth values, nouns are conventionally thought to denote sets of entities per world of evaluation (type <e,t>). By contrast, adjectives denote at the type of degrees; e.g., in every world, *long* denotes a function, f_{long}, from entities to their degrees on the length dimension (type <e,d>).

Notice, however, that the comparison constructions in (2)-(3) are *within-predicate comparisons*, namely, comparisons of two entities along the dimensions of a single predicate, as in (3). By contrast, the *between-predicate comparisons* in (4)-(5) involve comparisons of either one or two entities along the dimensions of two different predicates. Many dimensional adjective pairs cannot felicitously co-occur in such comparisons (Kennedy 1999), as illustrated in (4), while between-noun comparisons, such as (5a) and its Hebrew equivalent (5b), appear generally felicitous. They are clearly not as marked as within-noun comparisons, such as (5c) and its equivalent (5d). A mediating particle *of* is mandatory for the latter to be felicitous, while the former are fine without mediation. The relative acceptability of nouns and adjectives in different comparison types awaits a more systematic study.

(4) a. #The table is longer than the sofa is heavy.
b. #The table is more long than the sofa is heavy.

(5) a. Rubinstein is more a pianist than a conductor.
b. Rubinstein yoter psantran me-menacea'x.
c. #Rubinstein is more a pianist than my son
d. #Rubinstein yoter psantran me-ha-ben sheli.

While multiple factors may affect acceptability, this paper explores the proposal that, in explaining morphological gradability more generally, an important factor is the role of dimensions in comparison. Classification under *long* is merely a matter of length, but classification under, e.g., *healthy* is a matter of degree in a variety of dimensions, such as blood-pressure, cholesterol and blood-sugar level. One can be healthy in some respects but not others. Thus, for adjectives more generally to be licensed in comparison constructions, it seems necessary that the comparison morpheme be able to access the dimensions for comparison (see also Kamp 1975; Klein 1980; Kennedy 1999, and Sassoon 2013a, among many others).

The relevance of dimensions can be seen in the fact that the interpretation of comparisons can be given paraphrases relating to dimensions. Examples (6a) and (6b) include paraphrases for within-adjective comparisons with a dimensional and a multidimensional adjective, respectively. Examples (6c) and (6d) include possible paraphrases for between-predicate comparisons with multidimensional adjectives and nouns, respectively. These paraphrases constitute intuitive hypotheses about the semantics of comparison that, therefore, deserve a more systematic study.

(6) a. *The sofa is 2 centimeters longer than the table (is)*: The difference between the degree of the sofa and the table in the dimension underlying entity classification as *long* or not, f_{length}, equals twice the degree of a centimeter.
b. *(Generally) John is healthier than Bill*: (Generally), the difference between the degrees of John and Bill in the dimensions contextually underlying entity classification as *healthy* or not, $f_{blood\ pressure}$, $f_{cholesterol}$, $f_{chickenpox, \ldots}$, exceeds zero.

c. *These two sofas are more similar than different*: The number of dimensions along which the two sofas classify as *similar* exceeds the number of dimensions along which they classify as *different*.
d. *John is more a linguist than a philosopher*: The percentage of dimensions of *a linguist* along which John classifies positively exceeds the percentage of dimensions of *a philosopher* along which John classifies positively.

These paraphrases suggest that comparison morphemes involve quantification over or counting of dimensions; e.g., it follows from (6a,b) that a degree difference in at least SOME dimensions of an adjective should be present for within noun comparisons to hold true. In positive multidimensional adjectives such as *healthy,* the requirement might be stronger such that a degree difference should generally be present in ALL or MOST of the dimensions. Furthermore, it follows from (6d) that a larger PERCENTAGE of dimensions of a noun in comparison to another noun should be observed in an entity for the between-noun comparison to hold true.

Sassoon (2013a) provides a detailed formal semantic model with dimension sets in the interpretation of predicates. The dimensions are themselves predicates, such as *healthy with respect to the flu* or *similar in shape*. Predicates (and dimensions) are associated with degree functions and sets of entities, those entities whose degree exceeds a classification threshold. The degree function and entity set of a predicate restrict and are restricted by the degree functions and entity sets of its dimensions in a systematic way. For simplicity sake, the discussions in this paper treat dimensions as mere labels of their degree functions. The symbol 'f' represents a degree function, and 'F' represents a degree function denoting expression (type <e,d>).

The following tests of dimension accessibility suggest that the dimensions of (multidimensional) adjectives are more accessible than those of nouns for grammatical operations to operate on (Bartsch 1986; Landman 1989; Sassoon 2012, 2013a,b). Linguistic labels of operations on dimensions include prepositions, as in (7a), quantifiers, as in (7b), exception phrases, as in (7c) , and quantifying adverbs as in (7c), which on the relevant reading contribute that their adjectival argument holds in all (or most) respects. The dimensions sets of nouns, by contrast, are not easily accessible in this way, as the felicity contrast between the adjectival and nominal examples in (7) and (8) illustrates.

(7) a. healthy **with respect to** blood pressure; good **in** math.
b. healthy in {**some, most, every**} respect(s); different **in three** respects.
c. healthy **except for** high cholesterol; identical except in two respects, size and color.
d. **perfectly** healthy; {**mostly, completely, totally**} different.

(8) a. #bird with respect to size; #dog in movement.
b. #tiger in {**some, most, every**} respect(s); #table **in three** respects
c. #is a bird **except for** size; #is a snake except in two respects, size and color.
d. #**perfectly** (a) pine; #{**mostly, completely, totally**} a duck.

Accordingly, within-predicate *more* and similar degree morphemes may denote operations on dimensions, which are incompatible with nouns because it is impossible to access their dimensions. Within noun comparisons must include morphemes such as *typical of* that combine with the noun to provide a set of degree functions for *more* to operate on. Thus, e.g., in (3a-b) only the constituent (*typical*) *of an N* is capable of relating to the set of dimensions underling categorization in the noun, thereby providing a set for *more* to operate on (Sassoon 2013a).

To better understand the determinants of dimension accessibility, the following two sections review studies of the role of dimensions in categorization.

1.2 Quantification on dimensions in multidimensional adjective categorization

Consider the adjective *identical*. By default, native speakers intuitively judge entities as *identical* (generally, rather than with respect to color alone) iff they are identical in *all* (or *most*) of the respects that count as relevant in the given context. By contrast, they intuitively judge entities to be *different* iff they are different in *some* (at least *one*) respect. Objects are considered *clean* iff dirt of *no sort* (dust, stains, etc.) is attested on them, while they are considered *dirty* iff dirt of *some* sort is attested. Individuals with a slight cold are *not* strictly speaking *healthy*, since they are not *all* healthy, while one type of sickness suffices to count as *sick*.

Considering these, among many other examples, the following hypotheses emerge. The dimensions of positive adjectives (like, e.g., *identical*, *healthy* and *clean*) appear to be integrated by means of *universal quantifiers* (ALL, NO). By contrast, those of the negative antonyms appear to be integrated by *existential quantifiers* (SOME); e.g., intuitively, to count as healthy, one cannot have any serious disease, whereas to count as sick, one must have some disease. Hence, *healthy* seems to mean healthy in ALL respects, and *sick* – sick in SOME respects.[1]

Several corpus and judgment studies (Sassoon 2012, 2013b; Shamir 2013) explored these hypothetical ways to integrate dimensions into unified interpretations for positive and negative adjectives and nouns. They show that, as predicted, universal and existential quantification on dimensions is general among adjectives, but rare in concrete nouns. The methodology exploits the fact that exception phrases indicate universal quantification (von Fintel 1994; Hoeksema 1995; Moltmann 1995; Fox and Hackle 2006), as the contrast in (9a,b) vs. (9c) illustrates.

(9) a. Everyone is happy except for Dan
b. No one is happy except for Dan
c. #Someone is happy except for Dan

In accordance, speakers accept exception phrases with adjectives whose dimensions combine via an implicit universal quantifier ALL, but not with their negative antonyms, whose dimensions combine via an existential quantifier SOME, cf. the felicity contrast in (10a,b). Furthermore, negated universals are existential and vice versa. Hence, exception phrases are accepted with negated existential adjectives, but not universal ones, cf., (11a,b).

(10) a. I am **healthy** except for high blood pressure (bp) ($\forall F \neq bp$, I'm healthy in F)
b.#I am **sick** except for normative blood pressure ($\#\exists F \neq bp$, $\neg$(I'm healthy in F)
(11) a.#I am **not healthy**, except for (normal) cholesterol ($\#\exists F \neq ch$, $\neg$(I'm healthy in F)
b. He is **not sick**, except for the flu ($\forall F \neq flu$, He is healthy in F).

[1] We may consider one to be healthy despite, say, high blood-pressure only when this dimension is considered irrelevant. When using expressions like *all* or *everybody*, the standard practice is to ignore irrelevant entities (von Fintel 1994), but not to allow any other exceptions.

Notice also that the discourse in a given context may revolve around, e.g., cholesterol problems, such that *healthy* and *sick* would associate uniquely with this dimension. Thus, positive adjectives also have weak interpretations.

These judgments are supported by distributional patterns in 1300 naturally occurring examples of the form 'Adj. except' with 8 antonym pairs in positive vs. negative contexts as in, e.g., (10) vs. (11), respectively (Sassoon 2013). A two factor anova revealed an interaction between antonym polarity and context polarity ($F = 10.37$; $P < .001$). In positive adjectives, universality (frequency of implicit universal dimension integration, as in (10a)) is higher than existentiality (frequency of implicit existential dimension integration, as in (10c)). By contrast, in negative adjectives, universality is lower than existentiality. Moreover, universality is higher in positive adjectives than in their negative antonyms, whereas existentiality is lower.

These findings replicate the judgment survey results (Sassoon 2012), in support of the view that negative antonymy systematically affects the force of quantifier on dimensions. The dimensions of positive adjectives tend to be bound by a universal quantifier, ALL or NO, while those of negative antonyms tend to be bound by an existential quantifier, SOME. In other words, by default, multidimensional adjectives are used to convey generalizations on dimensions, while multidimensional antonyms relate to counterexamples to such generalizations.

On the same vein, Wattanmaker (1995) studied categorization in social versus natural kind concepts, but the adjective-noun distinction confounded his results. Most of the social concepts in his experiments were adjectives applicable to humans, and most of the natural kind concepts were nouns (animals and plants). The reported findings indirectly support the view that the former, but not the latter, tend to be interpreted by means of quantification (dimension counts), although the force of quantification may be weaker than that of a strict universal.

Additional data about nouns (e.g., *bird, chair, metal*; Murphy 2002) form strong evidence *against* quantification on dimensions. For examples, experts characterize a *metal* as an element that has metallic properties, such as electrical conductivity, thermal conductivity, ductility, malleability, strength, and high density. However, the conceptual and semantic structures underlying the word *metal* do not guide speakers, including experts, as to whether *all* or *some* of the dimensions have to hold for an element to classify as a *metal*. As a result, metallurgists fail to agree about the number of properties that have to hold – some say three, some say six, etc. (Murphy 2002: 18). Instead, the dimensions characterizing metals raise the degree to which an object exemplifies the category *metal*, which corresponds to its **averaged degree of similarity to ideal values in the dimensions** (cf., Wittgenstein 1953).

Mathematically speaking, similarity operations are mostly averaging functions (weighted-sums or -products), not Boolean operations. This is in accord with the fact that the noun dimensions are normally neither necessary nor sufficient conditions for categorization (Hampton 1995). Noun dimensions often are binary (e.g., 'wings' and 'beak' for *birds*) and many. In contrast to adjectives, conceptual gradability in nouns emerges due to averaging on many of them, not due to a single measurement. Indeed, a similarity structure for nominal concepts is extensively supported; e.g., it predicts classification likelihood and speed, retrieval time and memory accuracy (for review see Hampton 1998; Murphy 2002 and Sassoon 2013a).

Shamir (2013) directly compared adjectival antonyms to concrete nouns (mainly ones denoting animals and plants), showing that these nouns are less acceptable with exception phrases that operate on their dimensions than either positive or negative adjectives, in either negated or non-negated contexts ($P<.0001$; cf. *#bird/not a bird, except for flying*), in line with binding of nominal dimensions via similarity operations, instead of quantification.

At the same time, the 17 scores of stimuli of the form "noun except DIM" (based on averages over 4 dimensions per noun) also differed significantly ($P<.002$) from the rankings for 10 bad fillers, such as *The mirror is nervously black*, or *The book is slowly blue*. In fact, dimension

binding by means of similarity operations is the default in nouns, but context can override these defaults to some extent; e.g., in a context in which birdhood is defined by means of n genes, it is possible to felicitously state that a certain exemplar *is a bird except with respect to 3 genes.*

All in all, the reviewed findings support the view that adjectives can be represented as having a free dimension argument F. This argument can be saturated as in *is healthy w.r.t. blood pressure* which is the property of having a normative blood pressure, assuming blood pressure is a health dimension (with respect to ⇔ λFλPλx: F is a dimension of P. x classifies positively w.r.t. F). Alternatively, the dimension argument can be bound by an implicit quantifying expression equivalent to, e.g., *every, most* or *some*. As a default, the dimensions of positive adjectives are bound by universal or quazi universal quantifiers; e.g., entities classify as healthy iff they have no disease—they are healthy in every contextually relevant respect (*is healthy* ⇔ λx.Every(λF.F is a health dimension, λF. x classifies positively w.r.t. F). By contrast, the dimensions of negative adjectives are bound by universal quantifiers; e.g., entities classify as sick iff they have some disease—they are sick in at least one contextually relevant respect (*is sick* ⇔ λx. Some(λF. F is a health dimension, λF. x fails to classify positively w.r.t. F).

Moreover, the dimension argument can interact with other operations, including comparison morphemes; e.g., *more* in *X is more expensive than Y* selects the unique member of the dimension-set of *expensive* (the function from entities to their cost), and returns the relation of being more costly (λy.λx. Some(λF. F is a dimension of *expensive*, λF. x is F-er than y)). With the multidimensional adjective *healthy, more* can select one or more dimensions. The workings of multidimensional comparisons are yet to be studied. However, as illustrated in (6), the felicity of predicates P with *more* seems to depend on the accessibility of their dimension sets. In turn, dimension accessibility seems to depend on the extent to which the entity set denoted by predicates P can be modeled by means of a set of dimensions bound by a quantifier, as in the proposed semantic analyses of *healthy* and *sick*. Accordingly, within-predicate comparisons of the form 'more P' or 'P-er' are understood equivalently to λyλx.Quantifier(λF. F is a dimension of P, λF. F(x) > F(y)). Substitution of P and Quantifier by *long* and SOME, respectively, yields the paraphrase in (6a). Substitution by *healthy* and ALL, yields the paraphrase in (6b).

1.3 Independent vs. interrelated dimensions in categorization under nouns

We now turn to review psychological studies of concepts and categorization, which results lead us to expect that the dimensions of nouns denoting social vs. natural-kind concepts exhibit different levels of accessibility. An experimental study of these predictions directly follows.

On dimension-based categorization theories (see Hampton 1998 and Murphy 2002), entities classify by the degree to which they exemplify—resemble the prototype of—concepts P (or one of their sub-concepts, called *exemplars*). Similarity to P is determined by the extent to which their values on P's dimensions match the ideal values for a P. In support of similarity based categorization criteria, such as (12a), Hampton (1998) found a very strong coupling between the mean exemplariness ratings of items and the probability that they were categorized positively in about 500 items of 18 categories. Thus, this approach captures the fact that we can determine membership of infinitely many new instances, on the basis of a finite set of known facts. Newly encountered entities whose mean similarity is higher than that of known members can be automatically regarded as members. Lastly, in calculating similarity of an entity x to P, its dimensional degrees have to be added up. Thus, similarity is often approximated by a formula with a weighted-sum operation, as in (12b), or a weighted product operation, as in (12c).

(12) a. x counts as P iff x's degree of similarity to P is big enough: $f_P(x) \geq \text{Standard}(P)$.
b. Additive similarity of x to P: $f_P(x) = \text{Weight}(f_1,P) \times f_1(x) + \ldots + \text{Weight}(f_n,P) \times f_n(x)$.
c. Multiplicative similarity of x to P: $f_P(x) = f_1(x)^{\text{Weight}(f_1,P)} \times \ldots \times f_n(x)^{\text{Weight}(f_n,P).}$

Additive similarity is effective for modeling concepts in which the effects of different dimensions are independent, whereas multiplicative similarity is effective with interactive dimensions. Multiplication models cases in which the most radical decrease in similarity is between entities which perfectly match the ideal in all the dimensions and entities which mismatch in just one dimension. For instance, assuming, for simplicity, equal dimensional weights and dimensional degrees between 0 and 1, then even instances which match in all of the dimensions except for a 0.5 score in one dimension, have a low mean similarity, 0.5, because multiplication yields $0.5 \times 1 \times \ldots \times 1 = 0.5$ (Murphy 2002). Two 0.5 scores yield a mean similarity of 0.25, and so on (the decrease predicted by additive similarity is by far less drastic).

For example, each *bird* sub specie is associated with a bundle of dependent or interrelated dimensions, such as shape, color, behavior, genetic layout, inner biological function and offspring characterization. Multiplication models the fact that a shift in one dimension is usually sufficient to justify classification in a different sub specie. For instance, all robins resemble prototypical robins in being small, eating seeds and fruit, and communicating by singing, whereas all eagles resemble prototypical eagles in being big, eating animals, and communicating with calls. An entity which is somewhat a robin and somewhat an eagle would not classify as either; instead, it would classify as a new specie. In fact, dimension interrelatedness—multiplicative similarity—is recognized by a tendency for gaps between categories, whereas dimension independence—additive similarity—is recognized by category overlaps.

To study dimension integration in different noun domains (social artifacts vs. natural plants and animals), Hampton, Storms, Simmons and Heussen (2009) have invented scenarios with borderline cases. On one such scenario, a historical nuclear accident nearby a remote island resulted in the evolution of hybrid creatures, e.g., a subkind with some features of lobsters and some features of crabs, or a subkind with features of a pine and an oak. In a second scenario, a secluded community in a remote area had the habit of using artifacts in ambiguous ways so that, for instance, some pieces of clothing had features of both a scarf and a tie, and some places had features of both a church and an art gallery. Participants were asked to help scientists classify the creatures and artifacts they were presented with. The results exhibited a clear domain difference. In line with a multiplicative-similarity account, hybrids of two different natural kinds were often classified in neither one of the kinds. By contrast, in line with additive similarity, hybrids of artifacts were often classified in both categories.

Additional support of additive similarity in social concepts (e.g., human traits) comes from the finding that their categorization criterion can be represented by a simple counting strategy (Wattenmaker 1995). Entities that have most of the properties denoted by a concept's dimensions are classified positively. This case can be modeled with similarity operations assuming binary dimensions with equal weights, additive averaging, and a mid-scale criterion for categorization. This case is significant because it is the only case in which the effect of averaging reduces to an effect that can be represented via quantification by *most* (as in $N \Leftrightarrow \lambda x.\text{Most}(\lambda F.F \text{ is a dimension of N}, \lambda F.\ x \text{ classifies positively w.r.t. F})$. Thus, social-category labels can be represented as having a free dimension argument, which, by default, is bound by *most*. If so, the dimension

accessibility hypothesis predicts that these nouns be significantly more felicitous with dimension-binding operations, including exception phrases and degree morphemes like *more*.

The main advantage of the proposed approach to gradability and comparison over earlier ones is that it covers different types of predicates, including dimensional as well as multidimensional adjectives, and nouns of various domains. Here are a number of testable predictions.

Most importantly, a continuum of (in)felicity is predicted. All nouns are predicted to be less acceptable than adjectives in within-predicate comparisons, because as a default they cannot denote sets of accessible dimensions. However, nouns whose dimensions are by default independent (additive) are expected to be more acceptable than nouns with interrelated (multiplicative) dimensions. In particular, nouns denoting social categories and artifacts are expected to be more acceptable than nouns denoting animals and plants, as the comparison of examples in (13c-d) and (13a-b), respectively, aims to illustrate. Furthermore, between-noun comparisons may exhibit the same continuum, cf. (14c-d) vs. (14a-b). A continuum will support the thesis that the interpretation of between-noun comparisons involves counting and comparing the relative number of dimensions that an entity has of each one of the compared predicates. Hence, if a contrast along these lines can be found, this would yield support to an analysis in terms of dimension counts as suggested in (6c-d). By contrast, on an alternative account of noun comparisons whereby *more* makes direct use of the degrees to which entities resemble nouns, nouns of all sorts are expected to be equally felicitous in noun comparisons.

(13) Within-noun comparisons: "This P is more NP than that P (is)"
   a. #This piece of fruit is more an orange than that piece of fruit.
   b. #This farm animal is more a cow than that farm animal.
   c. ?This booklet is more a diary than that booklet.
   d. ?This artist is more a composer than that artist.

(14) Between-noun comparisons: "This P is more NP_1 than (that P is) NP_2"
   a. ?This piece of fruit is more an orange than an apple
   b. ?This farm animal is more a cow than that farm animal is a horse
   c. This booklet is more a diary than a sketchbook
   d. This artist is more a composer than that artist is a poet

(15) Dimensional exception phrases: "This P is (not) NP, except for/with respect to DIM"
   a. #This vegetable is (not) a potato except for color.
   b. #This predator is (not) a tiger except for its teeth number.
   c. ?This place is (not) a church except in appearance.
   d. ?This girl is (not) a genius except with respect to literature.

Finally, similar contrasts are expected to occur with quantifiers on dimensions and exception phrases that weaken generalizations on dimensions (henceforth, dimensional quantifiers and exception phrases), as in (15). Moreover, if dimension accessibility is a predictor of felicity in within- and/or between-predicate comparisons, then the felicity level of a predicate in these constructions is expected to correlate with its felicity with dimensional quantifiers and exception phrases. Thus, let us turn to discuss a felicity-judgment study that tests these predictions.

2. A study of felicity judgments

2.1 Method

The participants were recruited using Amazon mechanical Turk (AMT), an online labor market place where workers are paid small amounts of money to complete small tasks named HITs (Human Intelligence Tasks). It has been shown that AMT provides a quick and relatively cheap method to acquire high-quality experimental results that do not differ significantly in performance from standard experimental settings (Buhrmester et al. 2011). The hits were only visible to American workers. 25 different participants completed each hit. They were awarded 1 cent per hit consisting of a single item rating, with an average hourly rate of 6.5$. All the hits were completed in 18 July, 2013.

The items consisted of 6 adjectives, all positive and one-dimensional (*tall, heavy, big, old, expensive* and *colorful*), as well as 24 pairs of indefinite noun phrases denoting concepts from two general domains: natural kinds (plants and animals) and social concepts (human traits and artifacts), 12 pairs per domain. Each pair consisted of contrasting nouns, such as *duck* and *goose*, and *dress* and *night shirt*, mostly withdrawn from the stimuli reported in Hampton, Storms, Simmons and Heussen (2009). The pairs of human traits and professions were chosen from a list created by searching the corpus of contemporary American English (Coca, Davies 2010) for "(s)he is a XXX", with a restriction that the empty slot (XXX) be a noun.

Each one of the six adjectives occurred in 4 within-adjective comparisons ("This P is more AP than that P (is)") differing by the domain of the compared entities (plants, animals, artifacts and humans). Half the items in each domain were clausal (with *is*) and half were phrasal (without *is*), as in *This animal is taller than that animal is* and *This person is taller than that person.*

Each noun was used in seven conditions, with the same subject in each. Three different comparison conditions included within noun comparisons, and between noun comparisons with either a single subject or two subjects, as in (13), (14b,d) and (14a,c) (or table 1), respectively. In addition, the nouns occurred, either negated or not, with exception phrases, as in (15). These two conditions aimed to assess the compatibility of nouns with dimensional exception phrases, without giving reliable evidence for each particular noun, as each noun was matched with but one dimension (for studies with 4 dimensions see Sassoon 2012 and Shamir 2013). In addition, they formed fillers for the three comparison conditions.

Table 1: The 24 between noun comparisons with a single subject

	Animals		**Plants**
1	This farm animal is more a cow than a horse	1	This tree is more a pine than an oak
2	This insect is more a mosquito than a wasp	2	This vegetable is more a potato than a carrot
3	This bird is more a crow than a pigeon	3	This flower is more a dandelion than a rose
4	This reptile is more a snake than a lizard	4	This spice is more onion than mint
5	This predator is more a wolf than a tiger	5	This plant is more moss than grass
6	This aquatic mammal is more a dolphin than a shark	6	This piece of fruit is more an orange than an apple
	Human concepts		**Artifacts**
1	This journalist is more a consultant than a reporter	1	This place is more a church than an art gallery
2	This artist is more a composer than a poet	2	This piece of clothing is more a dress than a nightshirt
3	This football player is more a champion than a celebrity	3	This car is more a taxi than an ambulance
4	This girl is more a genius than a child	4	This hall is more a theatre than a cinema
5	This colleague is more a businesswoman than a friend	5	This container is more a carafe than a vase
6	This person is more a victim than a witness	6	This booklet is more a diary than a sketchbook

Two more conditions consisting of basic and negated categorization statements ("This P is (not) NP") served as baselines and balanced the number of predictably good and predictably bad sentences in the sample.

With 24 sentences per condition, the 8 conditions yielded 192 sentences. With 60 additional fillers of various forms, half bad and half good (see table 3), there were 252 sentences.

2.2 Results

The averages of the judgments of 25 participants per sentence served as the basis for the statistical analysis. The average score in the within-adjective comparison condition was 6.1 (SD=.55). Two pairs of animal labels had to be removed from all the noun conditions due to errors ('crew' and 'fly' were used instead of 'crow' and 'insect', respectively), and two plant pairs had to be removed due to their being mass nouns (onion-mint and moss-grass). Table 2 presents the resulting means per item and condition for the remaining pairs.[2]

Table 2: From left to right: Averages on 25 participants for the 24 nouns in the baseline conditions ("X is NP" and "X is not NP"), exception phrase conditions ("NP except" and "Not NP except"), single subject between-noun comparisons ("More NP1 than NP2"), within-noun comparisons ("More NP than y (is)"), and two subjects between-noun comparisons ("More NP1 than y is NP2").

	Item	X is NP	X is not NP	NP except	Not NP except	More NP1 than NP2	More NP than Y (is)	More NP1 than y is NP2
Animals	Cow	6.68	6.68	1.92	2.04	3.64	2.92	2.32
	Snake	6.72	6.64	3.64	4	4.84	3.6	3.16
	Tiger	6.52	6.76	2.32	1.96	4.28	3.28	2.84
	Dolphin	6.68	6.36	3.08	3.52	3.6	2.8	2.56
Plants	Pine	6.64	6.76	2.84	2.64	4.52	4.32	3.28
	Potato	6.64	6.32	2.88	2	3.16	2.12	2.2
	Dandelion	6.84	6.92	3.28	2.68	3.72	4.08	2.8
	Orange	6.68	6.64	3.04	2.48	3.6	3.4	2.48
Artifacts	Church	6.92	6.72	4.32	5.24	5.48	4.48	4.24
	Dress	6.72	6.84	2.88	2.84	5.44	3.8	2.8
	Taxi	6.52	6.84	3.24	3.48	3.72	4	2.92
	Theatre	6.12	6.12	4.32	3.64	5.04	4.08	3.44
	Vase	6.72	6.52	3.04	2.16	5.76	4.32	3.16
	Diary	6.16	6.92	4.08	3.56	6.2	4.44	3.32
Humans	Reporter	6.6	6	2.56	2.4	5.48	4.12	2.96
	Composer	6.8	6.84	2.72	3.84	5.76	4.76	3.12
	Champion	7	6.76	4.28	4.28	5.44	4.76	3.56
	Genius	6.84	6.88	5.04	5.16	4.32	5.24	2.12
	Businesswoman	5.72	5.16	3.08	2.76	4.88	4.32	3.16
	Person	6.8	6.84	2.56	3.08	5.2	5.2	3
	M	**6.62**	**6.58**	**3.26**	**3.19**	**4.70**	**4.00**	**2.97**
	SD	**0.30**	**0.42**	**0.79**	**0.98**	**0.90**	**0.80**	**0.50**

[2] Together with the removed items, all the statistical effects are more significant.

Table 3: Examples of the 60 good and bad fillers. [3]

Good fillers	Mean	SD	Bad fillers	Mean	SD
This chair is often covered	**6.16**	1.29	This chair is often wide	**2.28**	2.01
This inspector did not see anything	**6.8**	0.63	This inspector saw anything	**1.96**	1.46
This film is Italian except with respect to the music	**4.84**	1.99	This immigrant is an Italian except with respect to the accent	**3.08**	2.00
This film is not Italian except with respect to the music	**4.52**	2.04	This immigrant is not an Italian except with respect to the accent	**3.48**	2.23
Mean (n = 16)	**5.39**	**1.37**	**Mean (n =12)**	**2.44**	**1.62**

Table 3 presents the means for a sample of examples of the 60 good and bad fillers.

A nonparametric Wilcoxon signed-ranks test showed that the good fillers, in particular, the basic and negated categorization conditions, were significantly better than the single subject between noun comparisons, the best of the three nominal comparison types (W=210, n(s/r)=20, z=3.91, P<.0001 with negation and W=208, n(s/r)=20 ,z=3.87, P<.0001 without). The single subject between-noun comparisons, in turn, were significantly better than the within-noun comparisons (W=158, n(s/r)=19, z=3.17, P<.002), which were better than the two subject between noun comparisons (W=208, n(s/r)=20, z=3.87, P<.0001), as well as exception phrases with negated (W=174, n(s/r)=20, z=3.24, P<.002) and non negated nouns (W=171, n(s/r)=20, z=3.18, P<.002). The exception phrases were equally infelicitous with and without negation.

On a Mann-Whitney test, the adjectival within-predicate comparisons and best nominal comparisons differed significantly in felicity (mean ranks 30.8 and 12.5, respectively; U = 40, z = 4.7, P < .0001). Moreover, the items denoting natural kind concepts differed from the ones denoting social concepts in their felicity in within noun comparisons (mean ranks 5.4 and 13.9, respectively; U=7.5, z=3.09, P<.002), single subject between noun comparisons (mean ranks 5.2 and 14 respectively, ,U=5.5, z=3.24, P<.002), and two subject between noun comparisons (but with 94%CL or one-tailed P: mean ranks 7.3 and 12.6, respectively; U=22.5, z=1.93, P<.054, P1<.03). The two domains differed also in their felicity with exception phrases when the nouns occurred with negation (mean ranks 7.1 and 12.8; U=21, z=2.04, P<.041).[4]

Table 4 presents the rank order correlation coefficients and P values for the comparison by exception-phrase conditions (n=20, df=18). Notice the moderate to strong correlation between the felicity of dimensional exception phrases with negated nouns and the felicity of within noun comparisons (r=.58,t=2.98, P<.009) as well as two subject between noun comparisons (r=.44, t=2.1, P=.05, P^1<.03). The correlation with single subject between noun comparisons was weaker and only significant with a 1-tailed P at a 94%CL (r=.38, t=1.72, P<.11, P^1<.052). The felicity of non-negated nouns with exception phrases did not manifest significant correlations with their felicity in comparison constructions.[5]

[3] Most of the remaining fillers were of the form "X is Adjective compared to y", with adjectives that were expected to be good or not good in this construction, such as *expensive* vs. *empty*. The latter, however, scored highly with an average of 5.62 (Sd=.43) as opposed to 6.63 (SD=.20) for the former. Therefore, only the other 16 good fillers (M=5.39) and 12 bad fillers (M=2.44) were used for comparison with the felicity of the target conditions.

[4] Without negation, only one-tailed P yielded 90% level significance (mean ranks 8.3 and 12; U=30.5, z=1.31, P<.19, P^1<.1). All the results persisted after normalization of target conditions relative to the baseline, i.e., after subtraction from each score per noun the score of the basic categorization condition with that noun. For the exception phrases with negated nouns, the scores of the negated categorization condition served as baseline.

[5] The significance of the results persisted after normalization. Additional significant correlations were revealed between the different comparison types, i.e. between within- and between-noun comparisons (with a single subject: r

Table 4: Rank order correlation coefficients (n=20, df=18)

R	**X is NP except**	**X is More NP than Y**	**X is More NP1 than Y is NP2**	**X is More NP1 than NP2**
Not NP except	**0.75 (t=4.78,P<.0002)**	**0.58 (t=2.98,P<.009)**	**0.44 (t=2.1,P=.05, P1<.03)**	0.38 (t=1.72,P<.11, P1<.052)
NP except	1	0.33 (t=1.47,P<.16,P1<.08)	0.35 (t=1.59,P<.13,P1<.065)	Not sig.

2.3 Discussion

The results of this study are in line with the predicted continuum. Comparisons appear to be more felicitous with adjectives than nouns, as well as with social nouns (labels of human traits and artifacts) whose dimensions are relatively independent—feed an additive categorization criterion—than with natural kind nouns whose dimensions are interrelated—feed a multiplicative categorization criterion. Thus, the felicity of nominal comparisons matches the accessibility of the noun dimensions, i.e., the degree to which its default interpretation can be approximated by one based on dimensional quantifiers.

Notice, however, that the adjectives in this study were all one-dimensional, meaning that their interpretation is best described by means of a definite determiner on dimensions (e.g., since the only dimension associated with *long* is length, for an entity to classify as *long* it should be long w.r.t. THE unique dimension of *long*). One multidimensional adjective (*Italian*) appeared within the three comparison types, as part of the 60 fillers. Its averages scores (6.12 (1.21) for *This film is more Italian than American*; 5.24 (1.68) for *This film is more Italian than that film*, and 3.92 (1.79) for *This film is more Italian than that film is American*) are by far higher than the average scores of the nouns in the respective comparisons (4.70, 4.00, and 2.97), as expected. However, multidimensional adjective comparisons await a systematic future study.

As for the nouns, an account in terms of accommodation of binary dimensions with equal weights predicts that the interpretation of additive, but not multiplicative nouns become equivalent to one based on quantification (dimension counting). Previous studies of dimensional exception phrases suggest that quantification characterizes multidimensional adjectives (Sassoon 2012, 2013b, Shamir 2013). The present results suggest that the more a noun resembles an adjective in its default dimension-binding, the more acceptable it is in comparison constructions, suggesting that comparisons morphemes are operations on accessible dimensions.

Similarly, additive nouns are better than multiplicative ones with dimensional exception phrases, in particular when negated (as in "not an N except for dim"). This condition indicates the degree to which speakers are willing to interpret the noun N in terms of an existential dimensional quantifier. By contrast, the non-negated condition ("N except for dim") indicates the degree to which speakers are willing to interpret the noun N in terms of a universal dimensional quantifier. The results for the two conditions did not differ significantly, suggesting that neither existential nor universal quantification dominates, consistent with Shamir's (2013) results.

Moreover, only the results of the negated noun condition in the present study correlated with the results of the comparison conditions. This suggests that compatibility with existential

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= .68, t=4.2,P<.001 and two subjects: r=.5,t=2.45,P<.03), as well as between the two between-noun comparisons (r=.7, t=4.15, P>.0007). Finally, only adjectival phrasal vs. clausal comparisons constructions differed in felicity (mean ranks 16.7 versus 8.3, respectively; U=122.5, z=2.89, P<.004).

quantification is more important in predicting felicity in comparison constructions. A possible reason for this might be that comparisons are interpreted by existentially binding the dimensions of their predicative argument. Thus, their felicity correlates with the felicity of a construction that forces a noun to be interpreted as existential on its dimensions. To assess the validity of this interpretation, future research should assess the felicity of comparative predicates with dimensional exception phrases ("x is (not) more P than y except in dim"). If comparative predicates are predominantly existential, higher acceptability is expected in the negated case.

Notice also that the correlation between the felicity of negated nouns with dimensional exception phrases and in single subject between-noun comparisons did not reach significant. This may stem from the fact that each noun was matched with only one dimension, or from the fact that the degree of match between the two compared nouns also affects the felicity of between noun comparisons (but this holds of two-subject between noun comparisons, where the correlation was after all significant). At any rate, the present results fail to yield support for a general view of between-noun *more* as existential, as opposed to universal on the noun dimensions. Nonetheless, the clear preference of nouns with accessible dimensions over other nouns in these comparisons ($P<.002$) does support an interpretation based on a counting operation on accessible dimensions, an operation that yields paraphrases as in (6c-d) (see Sassoon 2014 for a detailed account along these lines). Further theoretical and experimental research of the semantics of this construction is required.

Notice that in the within-predicate comparisons in this experiment, the than-clause structure was as in *This football player is more a champion than that football player (is)*. A more natural clause would be *than that one (is)*. The idea was to block interpretations of *that one* as relating to a property, which would turn the comparison into a between-noun one. However, this feature may have reduced the felicity of these comparisons. At any rate, the two subject between noun comparisons were clearly the least acceptable among the nominal comparison types investigated, confirming predictions of the account by Sassoon (2014). On this account, their inferential import is normally too weak for them to be useful in communication.

The role of accessible dimensions in an account of morphological gradability can be assessed in the future using exception phrases with at least 3-4 dimensions per noun or adjective, as well as with other quantificational constructions, such as *P in every respect*, *some respect,* and *most respects*. Furthermore, future research can aspire to extend the continuum based on the present results by testing nouns and adjectives of additional domains (for instance, abstract nouns: *problem, result, reason, love*), as well as additive natural kind nouns and multiplicative social nouns, assuming such exist.

The present study has broader implications for our understanding of the adjective-noun word class distinction, including in particular nouny adjectives and adjective-like nouns. Consider in particular, nationality concepts such as *American* or trait concepts such as *extrovert*. They can fill in attributive-adjective positions as in *extrovert personality* and *American nationality,* but unlike most adjectives, they can also 'stand alone' in argument positions without any explicit noun around, as in *Americans* and *extroverts,* and unlike the ill-formed *#talls* and *#healthies* (see also lies 3-4 of table 3). This double life can be explained by categorization based on accessible dimensions. In argument position, the dimensions are bound by additive similarity functions, with equal dimensional weights. Since this type of interpretation can be represented by means of a dimension set bound by a quantifier, these nouns can also function as adjectives. The descriptive and explanatory power of this speculation has to be investigated in the future.

Additional implications pertain to size adjectives such as *big* and *huge*. When modifying certain nouns, size adjectives have readings in which they do not attribute big physical size (Morzycki 2009), as for example, in *this midget is a big fan*. Morzycki argues that this interpretation of *big* occurs when it modifies a noun that is itself morphologically gradable (e.g., *fan, stamp-collector, genius* or *idiot*). These nouns appear capable of denoting one of their gradable dimensions. For *idiot*, it is a measurement of stupidity (a mapping f_{idiocy} of entities x to degrees of idiocy); for *smoker*, it is frequency of or affinity for smoking. On this view, size adjectives function as degree modifiers, similar to *very* (type <d,t>); e.g., *big* denotes a mapping f_{big} of nominal degrees d to their relative size, $f_{big}(d)$.

Morzycki further observes that nominal gradability readings of size adjectives are absent in predicate position (as in *the fan is big*), or in negative size adjectives (as in *a small fan just came in*, which relates to physical size, not fan-hood). These features are unique to nominal-gradability readings, as opposed to abstract size readings (as in *this mistake is big/small*) and significance readings (*he is huge!*). The position generalization is captured by postulating a degree morpheme *meas* in the nominal degree projection, which is not available in other positions. *Meas* takes as arguments a gradable noun, a size adjective, and an entity and returns truth if and only if the entity falls under the noun and its degree in the noun classifies as big.

This account, however, of gradable nouns in terms of degree functions fails to explain why these nouns are not generally compatible with gradability morphemes such as *–er, –est,* and *too* (e.g., **faner, *fanest, *too fan*), and why their combinations with *more* must be mediated by a particle, as in *more of an idiot than Bill*. The results reported in this paper give rise to an alternative approach, which rests on the observation that the gradable dimensions of adjectives are often context dependent, and their choice is affected, among other things, by the noun they modify. For example, the dimension of *long* is different for tables than for stories, and the dimensions of *sick* are different for plants and humans. Assuming that nouns are themselves associated with dimension sets, size adjectives may, under certain circumstances, be able to access and operate on these sets.

The position generalization can be captured by postulating that, unless an adjective has a dimension set argument (as *typical* does in, e.g., *typical of birds*), only in attributive position can it access the dimension set of the noun it modifies (perhaps by virtue of a syntactic head whose semantics does the job). Thus, the position generalization can be explained using Morzycki's logic, without the need to stipulate that some nouns denote a degree function, while most other nouns do not, and that size adjectives in the relevant readings are adverbial (adnominal) modifiers in essence, while most other adjectives (or uses of size adjectives) are not.

This approach extends beyond size adjectives; e.g., to explain the different interpretations of *old* in *He is an old friend* and *This friend is old*. Thus, the availability of nominal dimensions for adjectives to operate on is a more general phenomenon in attributive position.

Moreover, the set of examples of gradable nouns reported in the literature typically includes nouns such as *idiot, nerd, soccer fan, airhead, goat cheese enthusiast, simpleton, Barbie doll lover, loser,* and *weirdo* (Morzycki 2009; de Vries 2010). It is easy to observe that all of these nouns belong to the social domain. This means that their dimensions ought to be relatively accessible to grammatical operations. Thus, the ability of a size adjective to access their dimension set should not be surprising. Moreover, these nouns differ from other nouns in having a dimension with a gradable adjective interpretation (e.g., an IQ scale for *idiot* and a scale of admiration levels for *fan*). These two properties enable size adjectives to access the noun dimension set and select a gradable dimension to use for their interpretation.

A correlate of the dimension accessibility account is the possibility of quantification on the dimensions of these nouns, when they have several gradable dimensions, as in *Vernon is an idiot with respect to his political views* and in *complete/total idiot* (De Vries 2010).

Dimension accessibility as a predictor of linguistic gradability is manifested in additional phenomena; e.g., in various languages human categories such as *boy* and *girl* directly combine with the modifier *very*, as in the Hebrew *meod yalada* ('very girl', 'very girlish/ immature') and the Spanish *Es muy hombre* ('is very man', 'He is very much a man'; Espinal 2013). Additive dimension binding for the noun *girl* makes its dimensions more accessible than those of most other nouns. The importance of gradable traits in the stereotype of girls (e.g., loving pink) can be stretched to the point that *girl* is interpreted as equivalent to *girlish*, thereby licensing degree modifiers such as *very* and comparisons such as *Dan is more a {child, girl, boy} than Sam is* (cf., the high scores of comparisons with social concept nouns in this study).

In sum, nouns carrying expressive or evaluative components such as *idiot*, *coward*, *hero*, or *child* in its metaphoric sense, get as close to gradable adjectives as nouns can get (Constantinescu 2011: 49-96). These nouns seem to have at least one important 'adjectival' dimension. This idea seems to give us a promising direction for theoretical and experimental future research.

To conclude, this paper reveals important connections between cognitive psychological findings and linguistic phenomena. Hopefully, these connections will contribute to an improved understanding of morphological gradability in nouns and adjectives. Moreover, a potential contribution of the results to cognitive psychology consists of an improved understanding of certain experimental results; e.g., Wattenmaker's (1995) methodology was confounded by an imbalanced number of nouns vs. adjectives across conditions. As explained, there are good reasons to think that this factor may have affected the results. This illustrates the importance of awareness to grammatical features of linguistic concepts in the cognitive psychological research of categorization. By raising this awareness, and by pointing out practical directions for future research, this paper aimed to deepen our understanding of the relations between the conceptual and the formal components of natural languages.

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