A Typology of Multidimensional Adjectives

Galit W. Sassoon,
ILLC, University of Amsterdam*

This paper presents corpus-based evidence for a typology of multidimensional adjectives, such as healthy *and* sick. *The interpretation of these adjectives is sensitive to multiple dimensions, such as blood pressure, cholesterol and blood-sugar level. The study investigated the frequency of exception phrases that appear to operate on an implicit universal quantifier over adjectival dimensions, as in* healthy, except for a slight cold, *and* not sick, except for high cholesterol. *On the emerging typology, adjectives classify by the way their dimensions are glued together to create a single, uniform interpretation. As a default, the dimensions of adjectives such as* healthy *are bound through implicit universal quantification, while those of adjectives such as* sick *are bound through existential quantification. In adjectives like* intelligent *the force of quantification over dimensions is context relative. Moreover, the paper presents support to the hypotheses that antonym polarity and modifier distribution guide our choice of quantifiers over dimensions in different adjectives. Thus, this research sheds new light on the nature of negative antonymy in multidimensional adjectives, and the distribution of degree modifiers amongst them. Finally, it raises new questions about multidimensional comparisons, and to the adjective-noun distinction.*

1. Introduction

1.1 Predicate typology based on dimension binding

Adjectives, such as *tall* and *bald* are often called *dimensional* because their interpretation is tightly dependent on entity values along a scalar dimension, e.g., height for *tall* and quantity of hair for *bald.* On a degree framework for the analysis of dimensional adjectives (Kennedy 1999, 2007), interpretation proceeds through translation to a λ-categorial language in the style of Heim & Kratzer (1998), with basic types x for individuals, t for truth values and r for degrees, and basic semantic domains D_x, D_t and D_r – sets of individuals, truth values and degrees, respectively. The interpretation of adjectives like *tall* in indices $c \in C$ ('contexts') includes two ingredients; (i) a function, $f_{tall,c}$, from entities $x \in D_x$ to degrees $r \in D_r$ representing their heights, and (ii) a standard of membership, $s_{tall,c,}$ such that *tall* holds true of an object x in c iff x's value exceeds *tall's* standard: $f_{tall,c}(x) > s_{tall,c}$.[1]

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[1]Kennedy (1999) views degrees as elements of a linearly ordered set, isomorphic to the real numbers. While the degree framework presented above provides simple and efficient means for delivering the main

Other adjectives are called *multidimensional* (Kamp 1975; Klein 1980), since they are associated with multiple dimensions. Typical examples include adjectives such as *similar*, *identical*, *typical*, *normal*, *good*, *clever*, *talented*, *happy*, *human*, and *healthy*. An adjective like *healthy*, for example, may be associated with many different dimensions simultaneously, such as blood pressure, cholesterol, cancer, lung functions, pneumonia, chickenpox, and so forth. One can be healthy with respect to blood pressure, but not with respect to cholesterol. Two entities may be *identical* or *similar* with respect to color, but not size. Conversely, an adjective such as *long* falls short of being truly multidimensional despite its having both a temporal and a spatial dimension, since it is interpreted only relative to one of these dimensions in each context, never relative to both simultaneously. Thus, not all word senses admit multiple dimensions.

On top of questions concerning the way adjectival semantics is affected by each scalar dimension, multidimensional adjectives pose difficult questions concerning the way a set of contextually relevant dimensions may be selected and the way information regarding different dimensions in such a set may be incorporated within context to create a single uniform interpretation for a given adjective. While the semantics of dimensional adjectives has been investigated in some detail, issues pertaining to the more complicated semantics of multidimensional adjectives have hardly been investigated within formal semantics.[2] This paper discusses some basic observations, based on intuitive judgments and a corpus study. This study does not test generalizations derived based on some existing explicit semantic mechanism; rather, it aims to highlight data-driven, descriptive generalizations. Based on the study reported in this paper, some general ideas about possible theoretical accounts arise, which may form a basis for future work on a formal theory. Hence, this study forms a preliminary stage in the research of multidimensionality; it sheds light on some pieces of the puzzle pertaining to what adjectives do and how they do that, and raises foundational questions for future research to address.

The above discussion suggests that the semantics of adjectives includes a dimension parameter. The reminder of part 1 explicates the notions of dimensions and dimension binding, sets forth hypotheses about dimension binding operations in different adjectives, and proposes a method to explore them based on the frequency of co-occurrence of adjectives with markers of universal quantification such as exception phrases. Part 2 presents the study. The results support the hypothesized association of default universal and existential dimension binding with positive and negative adjectives, respectively, and the hypothesized function of modifiers like *perfectly* as cues for universality over dimensions.

Dimensions of predicates like *healthy* can be represented as predicates in their own right, e.g., *healthy with respect to cholesterol*, *healthy with respect to the flu*, etc. Let DIM be a function from indices c and predicates P to sets of predicates, DIM(P,c), the dimensions of P in c. Examples (1a,b) show that a dimension can be specified through overt material in the syntactic derivation of sentences with multidimensional adjectives,

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ideas for this paper, nothing hinges on the decision to use it; see Klein (1991) for a review of different views about degrees and alternative frameworks for the analysis of gradable adjectives.

[2]Also within cognitive psychology and psycholinguistics, the study of such adjectives generally lags behind that of nouns, verbs, and adjectives of color or spatial distance (Damon et al 2006: 315).

such as preposition phrases headed by *with respect to* or *in*. Examples (1c,d) show that this option is not available for dimensional adjectives.

(1) a. The boxes are identical with respect to size and weight.
b. Sam is intelligent/good in mathematics.
c. #The wedding is long {with respect to, in} temporal duration (but not with respect to space).
d. #The table is long {with respect to, in} temporal duration (but not space).

These data suggests that multidimensional adjectives assign a 'respect' argument role, although respect arguments do not obligatorily surface in syntactic derivations. Such optional arguments are quite common. For example, the sentence *John ate* is felicitous; it conveys that John ate *something*, but a syntactic realization of the patient role is optional. On this analysis, the representation of *healthy* as it occurs in (1a) is equivalent to λQ.λx.healthy(x,Q). The predicate *healthy with respect to Q* – λx.healthy(x,Q) – can be used felicitously in a context c iff it is a member of DIM(healthy,c) (in words, Q is a health respect in c). It holds true of an entity x in c iff x's health with respect to Q exceeds the standard in c.

Alternatively, the dimension variable may enter the derivation by virtue of the preposition *with respect to* (wrt). On this analysis, phrases of the form *with respect to Q* are adjuncts – adjective modifiers whose job is to set the dimension parameter. Thus, e.g., *healthy with respect to Q* translates to λx.wrt(x,healthy,Q) and is interpreted as specified above for λx.healthy(x,Q).[3] The difference between an optional argument and an adjunct analysis of respect phrases is orthogonal to the purposes of this paper. Important to us is the fact that derivations with multidimensional adjectives may contain a dimension variable, in support of the view that their interpretation is sensitive to multiple dimensions. More evidence for the necessity of dimension representations is illustrated with examples (2a,b). The examples show that quantifying expressions can bind a dimension variable in sentences with multidimensional adjectives. Again, examples (2c,d) show that this option is not available for dimensional adjectives (Bartsch 1986; Landman 1989).

(2) a. The boxes are identical in {all, most, three, some} respects.
b. Dan is {generally, otherwise, all in all} healthy.
c. #The table is long in {all, most, three, some} respects.
d. #The wedding/table is {generally, otherwise, all in all} long.
(3) a. The boxes are identical except for their size.
b. In what respect is this venture wise?

Similarly, the availability of exception phrases and WH words that operate on adjectival respects further supports the appeal to a dimension parameter. To illustrate, example (3a) intuitively conveys that the boxes are identical in all but one of the contextually relevant respects. Example (3b) illustrates the availability of WH extraction.

[3]On this analysis, the infelicity of dimensional adjectives with *with-respect-to* phrases derives from a demand for a non-singleton dimension set to start with.

When speakers use bare forms of adjectives, as in *The child is healthy* and *Bill is similar to Mary*, they presuppose that their addresses can select contextually relevant respects. A syntactic dimension variable, if such exists, is implicitly saturated or bound. If no such variable is present in the derivation, still, an assignment of interpretation depends on the selection of some measurements or other of, e.g., health, or the existence or absence of a disease – body mass and fitness; chickenpox and pneumonia; etc. In addition, if more than a single dimension is involved, some binding operation OP binds the different dimensions, creating from them one property of individuals.

The *dimension binding operation* OP determines the way the interpretations of adjectives and their dimensions are mutually constrained. One plausible definition for DIM – the dimension assignment function – may include a requirement that P instances in c, for any adjective P and context c, would rank highly ON AVERAGE in the properties denoted by the dimensions in DIM(P,c). Another plausible definition may include a requirement that P instances would fall under ALL of these properties, or alternatively, SOME, MOST, MANY, or NONE of these properties, etcetera. The operations denoted by the expressions in capital letters are examples of possible dimension binding operations. Thus, bare multidimensional adjectives like *healthy* are equivalent to expressions of the form 'λx.x is healthy with respect to OP dimensions', and an open question is which operation OP binds the dimensions; e.g. are they normally bound by logical operations, as in *healthy in all/some respects*, or by non-logical operations, as in, for example, *healthy on average*?

Let us call an adjective P *conjunctive* iff it denotes the set of entities that fall under ALL of its dimensions, P $\Leftrightarrow$ λx.$\forall$Q$\in$DIM(P): Q(x). Let us call P *disjunctive* iff it denotes the set of entities that fall under SOME of its dimensions, P $\Leftrightarrow$ λx.$\exists$Q$\in$DIM(P): Q(x). For example, Hoeksema (1995) mentions in passing that, intuitively, the antonyms *healthy* and *sick* have default interpretations equivalent to *healthy in every respect* vs. *sick in some respect*. Consider, for instance, a context in which health is measured by the results of medical blood tests of blood pressure, pulse and blood-sugar level (a measure of diabetics), or alternatively, of pneumonia, flu, and chickenpox. Imagine that Dan has the maximal degree in two of these dimensions, but he is not within the norm in the third. Conversely, imagine that all of Sam's degrees are within the normative ranges, but they are the lowest possible, so Dan's mean on the dimensions is higher than Sam's is. Now consult your intuitions. Is Dan healthy? Why? Is Sam healthy? Why?

Dan's mean on the dimensions is higher than Sam's is. Nonetheless, intuitively, in this scenario, Sam is strictly speaking healthy, but Dan is not, because Sam, but not Dan, reaches the norm in all of the contextually relevant respects. Because of that, intuitively, Sam is healthier than Dan (for survey results along these lines see Sassoon 2012a). This judgment suggests that we do not compare directly Sam's and Dan's means on the dimensions. Had we done that, we would have judged Dan to be healthier than Sam. Rather, we fix negative and positive denotations for *healthy*, based on dimension intersection. For the positive denotation, we select entities that reach the standard in all of the dimensions. For the negative denotation, we select entities that do not do so. Only then (if at all), do we allow comparisons between denotation members (and between non-members), based on averaged degrees. These observations suggest that classification under multidimensional adjectives is based on *logical dimension-binding operations*. These adjectives are equivalent to Boolean compounds of their dimensions:

(4) Hypothesis set 1: A typology based on logical dimension binding operations
   a. Adjectives like *healthy* are by default **conjunctive**. Entities are required to reach the standard in ALL of their dimensions.
   b. Adjectives like *sick* are by default **disjunctive**. Entities are required to reach the standard in but ONE of their dimensions.
   c. Adjectives like *intelligent* are **mixed**. Pragmatics determines whether e.g., being intelligent in but one dimension (say, mathematics) suffices to count as intelligent, or every contextually relevant dimension counts.

Hypothesis (4c) is based on considerations of adjectives for which conjunctive and disjunctive interpretations are both intuitively plausible. These are the main proposals that this paper aims to put to empirical test. A plausible alternative to (4a-c) could be that classification is based on 'non logical' operations, such as *averaged similarity* to ideal health values (cf. Murphy, 2002, ch. 3), as stated in (5b):

(5) An Averaged similarity Hypothesis:
   a. A dimensional gradable adjectival phrase such as *healthy with respect to blood pressure* is **similarity-based**: The blood pressure of its instances has to be close enough ('similar') to the ideal blood pressure for their respective age group, gender, etc.
   b. Classification in multidimensional adjectives such as *healthy* is based on **averaged similarity**: The weighted sum of an entity's degrees of similarity to the ideal health values has to exceed a membership standard.

The difference between logical and non-logical (averaged-similarity) dimension binding is as follows. If classification under *healthy/sick* is based on averaged-similarity, for x to count as healthy/sick, x's degree of health with respect to, e.g., blood pressure times the weight of this dimension, plus x's degree of health with respect to cholesterol times the weight of this dimension, plus x's degree of health with respect to lung functions times…, and so on, has to exceed/not to exceed a threshold for membership in the category. By contrast, if classification under *healthy/sick* is based on logical rules, for x to count as healthy/sick, it has to be/not to be the case that x's blood pressure is close enough to the ideal blood pressure, AND x's level of cholesterol is close enough to the ideal level of cholesterol, AND x's lung functions are close enough to the ideal for lung functions, and so forth.[4]

Extensively supported concept-theories, including among others Prototype and Exemplar theories, analyze the concepts underlying nouns and adjectives by means of similarity. For a lengthy review of theories and experimental support, the reader is referred to Murphy (2002: ch. 3) and Hampton (1995, 1998). The name *similarity* highlights reference to ideal values, but the defining characteristic binding the multiple and variable accounts within the similarity approach is, rather, the rejection of logical

[4]Notice that the question is NOT whether the standard for a given dimension is based on the average degree of the entire population on that dimension or not (cf. Kennedy 2007), but rather whether the sum of different dimensional degrees is compared to a standard, or alternatively, each degree is compared to its own standard, such that all of the dimensions contribute categorization criteria.

dimension binding, in favor of non logical functions such as averaging (e.g., weighted sums or products). In fact, the similarity based approach came into being as a response to the Classical theory, namely a family of accounts that are bound together by the use of logical dimension binding operations, such as conjunction and disjunction (Lakoff 1987: ch. 1; Murphy 2002: ch. 1). Cognitive-linguistic theories incorporate the psychological similarity structures into the representations of the meaning of words (Lakoff 1987). However, these theories do not specifically address multidimensional adjectives, and the special ways their dimensions are bound.[5]

The main goal of the research reported in this paper is to seek evidence for multidimensionality in the adjectival domain, including evidence for default dimension binding operations in various types of adjectives. This paper presents preliminary corpus evidence in support of the typology of conjunctive and disjunctive adjectives in (4). It focuses on comparisons of positive and negative antonyms, and partial, relative, and total adjectives. The latter differ by their standard of membership being the minimum, a midpoint, and the maximum degree, respectively, in the range of the adjectival degree function – the adjective's *scale* (Kennedy & McNally 2005). A related goal is to explore how speakers might learn the default dimension-binding operations of adjectives, if such exist, from patterns of usage. For a comparison with nouns see Sassoon (2011, 2012b).[6]

1.2 A new method to explore concepts and implicit operators

The context-dependency of the adjectival dimensions makes it difficult to support or refute hypotheses about dimension binding experimentally. Consider, for instance, the conjunctive dimension-binding hypothesis in (4a). One way to test it is to design a questionnaire to assess classification data in adjectives and their dimensions. This questionnaire will have to control each participant's dimension selection completely, in order to say whether participants in fact treat all of the dimensions they select for *healthy* as categorization criteria, as the proposal in (4a) predicts, or not, counter (4a).

A main difficulty with this direction of investigation is that quantification in natural languages is contextually restricted. Thus, in everyday use, one can have high blood pressure, yet check 'healthy' on medical questionnaires. This is possible in contexts in which blood pressure does not count as a relevant dimension. Significantly, quantification over adjectival respects is by no means special in admitting context restrictions, as observed by Lewis (1979) and von Fintel (1994), among many others. For example, normally, utterances of statements such as *everybody came to the party* do not convey that everybody in the universe, state, or city came. Nor is it necessary that everybody we know of has been there; the statement is only about everybody that counts

[5]Most of the dimension binding operations employed by similarity-based analyses can be expressed by means of a general formula, which is known in mathematics under the name 'the generalized weighted-mean function' (Weidman 1993). The theories and generalized formula are presented and explained in detail in Murphy (2002: 67-68) and Sassoon (2012c: 94). However, the explicit classification of these theories as based on averaging, given their resort to this generalized formula, is by no means widespread in psychology. The present paper highlights this name as it aims to explore the contrast between 'mean-based' operations of dimension binding and logical 'quantificational' operations.

[6] For a general discussion of issues pertaining to the metaphysics of dimensions, the way to incorporate dimensions into formal semantic models, and related matters see Sassoon (2012c).

as relevant. Similarly, when we say that *the Netherlands is flat*, what we are saying is that it has *no bumps*, except for those that we ignore.

Some contexts require high standards of precision – it is more difficult to ignore entities on the basis that they are unimportant or irrelevant; e.g. normally, if one is healthy in every respect except for a slight cold, one is loosely speaking *healthy*. But in a context of a pre-surgery medical examination, ALL dimensions, even unimportant ones, count. One is not strictly speaking *healthy* if one has a slight cold; hence, one would not check 'healthy' upon filling a medical questionnaire in such a context.

Instead of designing a questionnaire that addresses the difficulties context restrictions pose, the present paper takes on a different direction of investigation. The focus of this investigation is the pattern of usage of a marker of universal quantification – the exception phrase *except* – with different adjectives. The method is based on the fact that exception phrases are compatible with universal quantifiers such as *every* and *no*, but not with existential ones, as the contrast in felicity between (6a,b) and (6c) illustrates (von Fintel, 1993, 1994; Hoeksema 1995; Moltmann 1995; Fox & Hackl 2006).[7]

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

The position of exception phrases such as *except* in a sentence is relatively free:

(7) a. Except for Eve, every woman has a mother.
b. Every woman has a mother, except for Eve.
c. Every woman except for Eve has a mother.

According to the Substitution Analysis of free exception phrases (Hoeksema 1995), the interpretation of the examples in (7) is based on the two statements in (8). Exception phrases take a sentential argument S (e.g., (8a)) and an exception argument A (*Eve*). The translation of *except for* is the one given in (9).

(8) a. Every woman has a mother.
b. Eve does not have a mother.

(9) Except for $\Leftrightarrow$
$\lambda A_a.\lambda S_t$, s.t. $\exists X_{at}, Y_{at}$: S $\Leftrightarrow$ Every(X,Y).
Every(λx_a. X(x) & $\neg$(x = A), Y) & $\neg$Y(A)

The interpretation has three components, a felicity condition, an entailment, and an implicature. First and foremost, for exception phrases to be felicitous, their sentential argument S has to be interpreted as semantically equivalent to a universal statement "every X is Y", such that X and Y – *woman* and *has a mother* in (7) – are selected based on S's constituents and focus structure. They denote entities in the same domain as the exception argument, e.g., *Eve* (for more details and comparison with previous analyses

[7]Note that (6c) is infelicitous, except in an alternative, 'in addition to' interpretation, whereby someone is happy in addition to Dan. An interpretation whereby Dan is presumably not happy is unavailable here. The 'in addition to' interpretation is not salient for many speakers, who reject (6c) altogether.

see Hoeksema 1995). Second, exception phrases entail any statement of the form "x is Y", for any x in X, excluding the statement "A is Y". Third, they imply that A is not Y (e.g. (8b)). Hoeksema considers this implication a Gricean implicature, while von Fintel (1994) and Moltmann (1995) incorporate it into the truth conditions. (10a) shows that examples (7a-c) satisfy the felicity requirement of equivalence of S to a universal statement; (10b,c) present the entailment and implication. Additional examples follow.

(10) Except for Eve, every woman has a mother:
  a. Every woman has a mother ⇔ Every(λx. woman(x), λx. x has a mother).
  b. Every(λx. woman(x) & ¬(x = Eve), λx. x has a mother).
  c. ¬(Eve has a mother).

(11) Except for Bill, nobody is late:
  a. Nobody is late ⇔ Every(λx. person(x), λx. ¬(late(x)).
  b. Every(λx. person(x) & ¬(x = Bill), λx. ¬(late(x)).
  c. ¬¬late(Bill) ⇔ late(Bill).

(12) *Except for Eve, some woman has a mother:
  It is not the case that:
  Some woman has a mother ⇔ Every(λx. woman(x), λx. x has a mother).

The postulated felicity condition captures the distributional properties of exception phrases. At the same time, it has the advantage that it does not require the existence of a universal expression in the derivation. A negated existential statement suffices for the licensing of an exception phrase because its truth conditions are equivalent to those of a universal statement. This is illustrated by the contrast between, e.g., (12) and felicitous statements with negated existential indefinites, such as *Except for Mary, I didn't see a soul* (Hoeksema 1995).[8]

Returning to multidimensional adjectives, exception phrases can operate on universal quantifiers over their dimensions, as in *healthy in every respect except for a slight cold*. Importantly, they can do so also if the quantifier is implicit, as in *healthy except for a slight cold*, as long as the adjective's truthful application is compatible with the requirement that ALL (or NONE) of the properties corresponding to its dimensions be true of its argument. Therefore, exception phrases can reveal the force of the operations that bind the dimensions of multidimensional adjectives.

We can formulate the following hypotheses. If an adjective is *conjunctive* – a universally quantifying operation binds its dimensions when it occurs bare (cf. (4a)) – exception phrases are expected to co-occur with the adjective and operate on the implicit universal quantifier over dimensions, as (13a) illustrates. (13b) is true in a context c iff John is healthy with respect to ALL dimensions except for the flu in c (∀Q∈ DIM(healthy,c) – {healthy with respect to the flu}: $[[\text{John is Q}]]_c = 1$), and (13c) is implied: $[[\text{John is not healthy with respect to the flu}]]_c = 1$. By contrast, if an adjective is *disjunctive* – an implicit existential quantifier binds its dimensions (cf. (4b)) – exception

[8]Notice that the preposition *for* may sometimes be dropped, as in *everybody came, except me, ha!*, and the exception argument A can be surrounded by additional material in particular other prepositions, as in *He is always here, except in summer* or *The code works everywhere except on windows operating systems* (for a discussion of examples in Dutch and their analyses see Hoeksema 1995).

phrases are expected to be unacceptable due to violation of their felicity condition, as (14) illustrates.

(13) Except for the flu, John is healthy:
  a. John is healthy ⇔ Every(λQ. health-respect(Q), λQ. Q(J)).
  b. Every(λQ. health-respect(Q) & ¬(Q = healthy with respect to the flu), λQ. Q(John)).
  c. ¬(John is healthy with respect to the flu).

(14) *Except for cancer, John is sick:
  It is not the case that:
  John is sick ⇔ Every(λQ. sickness-respect(Q) & ¬(Q = sick with respect to cancer), λQ. Q(John)).

(15) a. Dan is healthy, except for high blood pressure
  b. #Dan is sick, except for normal blood pressure

In the case of *healthy* and *sick*, these predictions are supported by intuitive judgments, as the felicity contrast in (15a,b) illustrates. Furthermore, negated universals are existential and vice versa. Hence:

(16) a. *healthy* ⇔ healthy in every respect **iff**
  not-healthy ⇔ 'not-healthy' in *some* respect
  b. *sick* ⇔ sick in some respect **iff**
  not-sick ⇔ sick in *no* respect

Thus, exception phrases are expected to combine with negated disjunctive adjectives, as (17a) shows. (17b) is true in a context c iff except for having flu, John is sick with respect to no dimension in c: $\neg\exists Q \in DIM(sick,c) - \{$sick with respect to the flu$\}$: $[[$John is $Q]]_c = 1$, i.e. $\forall Q \in DIM(sick,c) - \{$sick with respect to the flu$\}$: $[[$John is $Q]]_c \neq 1$. (17c) is implied: $[[$John is sick with respect to the flu$]]_c = 1$. By contrast, exception phrases are expected not to combine with negated conjunctive adjectives. Again, these predictions are supported by intuitive felicity contrasts as in (18a,b).[9]

(17) Except for the flu, John is not sick:
  a. John is not sick ⇔ Every(λQ. sickness-respect(Q), λQ. ¬Q(John)).

[9]Crucially, the distribution of exception phrases is restricted to 'positive' (upward entailing) contexts (Fox & Hackl 2006), meaning that, indeed, no exception phrases are expected to occur with conjunctive adjectives when negated, especially not in written corpora. Thus, the reading of *#Dan is not healthy (in every respect) except blood pressure* whereby negation out scopes the implicit universal quantifier (as in "it is not the case that: Dan is healthy in all respects except bp") is generally not available. I am indebted to Danny Fox for these observations. Here are two rare examples of this sort from the corpus of contemporary American English (Davies 2010; http://corpus.byu.edu/coca/). (iia) can only convey (iib) for vomiting cannot be healthy. Speakers tend to judge this naturally occuring example as utterly unatural.

(i) It is fallacious to claim that the U.S. health care system is pretty good except that it costs more.

(ii) a. … the infant was not healthy except for the regurgitation or vomiting
  b. In addition to regurgitation or vomiting, the infant was not healthy also in other respects.

b. Every(λQ. sickness-respect(Q) & ¬(Q = sick with respect to the flu), λQ. ¬Q(John)).
c. ¬¬(John is sick with respect to the flu) ⇔ John is sick with respect to the flu.

(18) a. Dan is not sick, except for high blood pressure
b. #Dan is not healthy, except for normal blood pressure

Exception markers can be used as conjunctions of two adversative statements S and S_A, as in *I would like to come, {but, except} I can't*. With adjectives, we find examples such as *The boxes are identical except (for the fact) that one is bigger than the others are*. Here S presents a generalization (*The boxes are identical* is understood as conveying that the boxes are identical in every respect), and S_A entails the existence of an exception to it (the boxes are not identical in size). Thus, such examples were included in the following discussion and study.

Hence, we can test quantitatively the predictions of the proposal that adjectival dimensions are bound by logical operations, rather than by averaging or related non-logical operations, by searching corpora for exception phrases preceded by adjectives and checking whether they can operate on implicit quantifiers over dimensions.

An essential element for the success of such a study lies in a careful control of other roles logical operations might play in the interpretation of adjectives. The next section discusses the role of universal and existential quantifiers in determining the membership standard of different adjectives, as well as the role of negation in determining the polarity of adjectival antonyms. It presents the hypothesis that standard type and antonym polarity reveal whether dimension binding is by default conjunctive or disjunctive. They function as cues for determining the force of implicit quantifiers over dimensions in bare occurrences of multidimensional adjectives.

1.3 Logical operations in the interpretation of adjectives

1.3.1 Antonym polarity as an indicator of dimension binding

On a negation theory of antonymy, negative antonyms are negations of their positive counterparts. For example, on the syntactic negation theory of antonymy (Heim 2006, 2008; Büring 2007), instead of being specified in the lexicon, antonyms are formed by a predicate negation operator *little*, hidden in their logical form. For example, *short* decomposes into a multiword expression equivalent to *little tall*.

A negation theory of antonymy predicts that the force of quantification over dimensions will vary systematically in antonym pairs because of compositional processes, i.e. the application of a negation operator in negative antonyms. For example, if to count as healthy one has to be maximally/much healthy in every dimension AND *sick* is the negation of *healthy*, then to count as sick one should count as not-healthy, i.e. not maximally/much healthy in at least one dimension. Similarly, if to count as *familiar* it suffices that an object be minimally familiar in but one respect, then to count as *unfamiliar* an object should count as not at all familiar in every respect. Formally, if, e.g., *healthy* is equivalent to λx.∀Q∈DIM(healthy), Q(x), *sick* as the logical negation of *healthy* should be equivalent to λx.¬∀Q∈DIM(healthy): Q(x), which reduces to

$\lambda x.\exists Q \in DIM(healthy)$: $\neg Q(x)$. Hence, hypothesis 2a in (19a) derives from a negation analysis of antonymy:

(19) Hypotheses-set 2: Antonymy as a predictive factor
a. Antonyms differ with respect to the default force of the quantifier binding their dimensions: A is conjunctive if and only if A's antonym is disjunctive.
b. Positive adjectives are conjunctive; negative adjectives are disjunctive.

Moreover, hypothesis 2b in (19b) originated from a preliminary investigation of naturally occurring uses of *except* in *The Corpus of Contemporary American English* (henceforth COCA, Davies 2010; http://corpus.byu. edu/coca/). This is the largest balanced corpus of American English, with more than 400 million words of text, equally divided among spoken, fiction, popular magazines, newspapers, and academic texts. It turns out that approximately half (57%) of the uses of *except* preceded by the adjectives *healthy, similar, identical* and *normal* (45 out of 87) involve implicit quantification over dimensions, and in accordance with a conjunctive analysis, none of these examples is negated. Nor is any of the cases of explicit quantification over dimensions negated. In addition, in accordance with a disjunctive analysis, the single example of implicit quantification over dimensions (out of 6 in total) with the antonyms *sick, dissimilar, different*, and *abnormal*, is negated, and so are all of the 4 cases of explicit quantification over dimensions.

These findings are consistent with the hypotheses that some multidimensional adjectives classify as conjunctive; others classify as disjunctive; antonyms of conjunctive adjectives are disjunctive, and vice versa. Moreover, interestingly, the results are consistent with an analysis of positive adjectives as conjunctive and negative adjectives as disjunctive. However, the data is too scarce to draw any solid conclusions. The absence of exception markers operating on dimensions of negated positive adjectives may merely reflect the low frequency of negated forms compared to non-negated forms in natural use. To test whether positive adjectives are indeed conjunctive, the study reported in part 2 is based on a corpus built from data drawn from the internet, including abundant exception markers preceded by negated adjectives.[10]

1.3.2 Standard type as an indicator of dimension binding

Importantly, also the interpretation of dimensional adjectives may involve quantification (Yoon 1996; Rotstein & Winter 2005; Kennedy & McNally 2005). For example, the interpretation of *total* adjectives – adjectives whose standard of membership is the maximum on their scale, like *closed, empty, full* and *invisible*, involves no quantification over dimensions; yet these adjectives are equivalent to expressions involving universal quantification over individuals or degrees. For example, intuitively, only maximally invisible entities are *invisible* (Kennedy & McNally 2005); i.e., entities are *invisible* iff they are equally or more invisible than ALL other entities; iff for ANY degree, they are invisible to that degree or more ($\forall r \in I$, $f_{invisible}(x) \geq r$, where I is the set of invisibility

[10]Notice, however, that conclusions pertaining to disjunctivity are strengthened: More exception phrases operating on dimensions were observed with the negative adjectives in negated than in non-negated contexts, despite the low frequency of the former in comparison to the latter.

degrees). By contrast, *partial* adjectives – adjectives whose standard of membership is the minimum on their scale, like *open* and *visible*, are equivalent to expressions involving existential quantification. For example, to count as *visible* it suffices to be minimally visible (Kennedy & McNally 2005); i.e., entities are *visible* iff they are more visible than SOME entities (the completely invisible ones); iff they are more visible than SOME degree (zero visibility; $\exists r \in V$, $f_{visible}(x) > r$, where V is the set of visibility degrees).[11]

Importantly, the total/partial distinction is different from the conjunctive/disjunctive distinction. The former applies for each dimension separately, whereas the latter is rather about the way judgments of membership in all of the dimensions together determine membership in the adjective. Yet, both distinctions determine a typological classification of adjectival interpretations by means of a default force of a quantifier.

For Yoon (1996), the scales of partial and total adjectives reflect the relative part of a plural individual that falls under the adjectives; for example, the relative part of an individual that is *visible*; the quantity of chairs in a room which are *empty*; the relative part of one's head that is not covered by hair, etc. Hence, rather than degrees, parts are bound by either universal or existential quantifiers; e.g., entities are *invisible* iff ALL of their parts are invisible, and they are *visible* iff they have SOME part which is visible.

Some modifiers are explicit markers of maximum and minimum operations, or equivalently, quantifiers over parts or degrees, as in, for instance, *completely clean/ invisible*, and *slightly dirty/visible*, which contrast with less frequent combinations such as *completely dirty/visible* and *slightly clean/invisible*. Syrett (2007) and references therein present corpus data supporting the view of, e.g., *slightly* and *completely* as partial and total modifiers, respectively. We also find naturally occurring examples of exception phrases operating on universal quantifiers over degrees or parts of entities in total adjectives and negated partial adjectives (COCA 2010). (20) presents a few of the abundant examples of the former, with the total adjectives *empty*, *bald*, and *closed*; no equivalent examples with the partial antonyms *open* and *hairy* are found in the corpus.[12]

(20) a. Entirely bald except for a fringe of grey hair.
b. Malcolm sat in a tiny room, empty except for his chair.
c. The church parking lot is empty except for the cars in the spaces marked "Seniors Only."
d. The ocean salmon fishery is closed except for the Elk River

Likewise, as illustrated in (21), none of the examples of *invisible except* in COCA to date (20/07/2010) is negated. In sharp contrast, all of the examples of *visible except* are negated or admit some negative-polarity operator, as in (22).

[11]In practice, often, maximum and minimum operations are used instead of quantifiers, but for the argument to go through, this makes little difference. It suffices that the result is equivalent to a representation by means of quantification.

[12]It is possible to say, e.g., *The resort is open except for the slopes at the lowest elevation*. However, crucially: (i) such an utterance necessarily conveys that all of the slopes are open (except those that are mentioned), not just one of them, and (ii) interestingly, no examples of this sort are actually attested in COCA to date, while abundant equivalent examples with the antonym *closed* are attested.

(21) a. he was below again, invisible except for roiling water and an explosion of bubbles.
b. silent rain, invisible except for brief appearances against dark backgrounds.
c. tall, dressed in black, invisible except for his hands and face.
d. holding a large picture in place, invisible except for dust and the faint, silvery outline.
e. its blackness made it invisible except for the dimples of its feet.
f. The criado, invisible except for his eyes.
g. The webbing was clear and invisible except where leaves or dirt had become attached.

(22) a. the elevator rides **wasn't** usually visible except for the bright strobe lights that warned fliers away.
b. **Nothing** of the spook's face was visible except a bristly bearded mouth.
c. **few** things are visible except the Sun, Moon, Jupiter, and Venus.
d. So smeared with blood that the corpse inside **isn't** visible except for its massive bulk.
e. **no** nearby motion was visible except our signing.
f. with **no** skin visible except their eyes.
g. the underside of the roof is **no longer** visible except for a one- or two-inch strip at the roof peak.

The data in (21) could be explained by tendency of speakers to avoid double negation, as in *not invisible*, which can be seen as conveying "not not visible"; but this tendency does not explain the prevalence of examples in the negative in (22). All considered, this data supports a classification of *invisible* and *visible* as having a default maximum- and minimum-standard, respectively, as these two types of interpretation reduce to universal and existential quantification over parts/degrees, respectively.[13]

Table 1 presents examples of adjectives sorted by their standard and polarity.[14]

Table 1 Typology of Adjectives by their standard type and polarity

Standard ~~**Polarity**~~	**Negative**	**Positive**
Partial (minimum-standard): P ⇔ P to some degree	Sick, Wet, Open, Dirty	Familiar, Visible, Similar, Healthier, Sicker, Better, Worse
Total (maximum-standard): P ⇔ P to every degree	Unfamiliar, Invisible, Dissimilar	Healthy, Dry, Closed, Clean, Identical, Full, Empty
Relative (midpoint-standard): P ⇔ P to a context dependent degree	Short, Heavy, Stupid, Ugly	Tall, Thin, Intelligent, Beautiful

[13]Exception phrases associate more naturally with universal quantifiers over parts as in (21)-(22) than over degrees, as in *The door was closed, except for one degree of aperture*, and in the naturally occurring example: *I was off sick, except I was only half-sick, the rest was tiredness*. The latter conveys reduction of degree: rather than being completely sick – sick to any degree – the speaker admits being only half-sick, sick to less than the maximum.

[14]It is normally assumed in the literature that the scales of relative adjectives have no maximum and minimum points, and therefore these adjectives can neither be total nor partial (Kennedy 2007).

Returning to dimension binding, one question is whether an adjective's default standard type (in particular, maximum vs. minimum) and default dimension-binding (conjunctive vs. disjunctive) are systematically connected in the following way:

(23) Hypothesis set 3: Standard type as a predictive factor
   a. A is conjunctive if and only if A is total (selects a maximum standard).
   b. A is disjunctive if and only if A is partial (selects a minimum standard).
   c. A is mixed (its classification as conjunctive or disjunctive is balanced across contexts) iff A is predominantly relative (neither total nor partial).

The connections in (23a-c) are not logical necessities, but they may hold due to more than a mere coincidence. Here are three ways to causally link between standard type and dimension binding.

One possibility is that standard type is a more basic property of adjectives than their default dimension binding type, and it affects the choice of a dimension-binding operation. Consider, for instance, *healthy* and *sick*. Let H be a uniform health scale, and $H_1 \ldots H_n$ be the scales of the health dimensions – the factors that, taken together, help to build H. Assume that to count as healthy, one must be maximally healthy relative to H (a maximum-standard). Therefore, to count as healthy, one must be maximally healthy in **all** of the contextually relevant dimensions $H_1 \ldots H_n$ – if some entity y is healthier than an entity x in one of these respects, H_i, x is not at the maximum of H, and therefore cannot be healthy. Hence, conjunctive binding follows from an assumption of maximum standard for H. Now assume that *sick* is associated with the same scale H, except that the maximum of H – maximum health – functions as the zero point of *sick*. Assume that to count as sick, it suffices to be minimally (somewhat) sick, i.e. to fall minimally short of the maximum of H (minimum-standard). Then, to count as sick, it suffices for one to be sick in **but one** dimension – to fall minimally short of the maximum of either one of $H_1 \ldots H_n$. Hence, disjunctive binding follows from an assumption of minimum standard.

In sum, the force of quantification over dimensions may derive from standard type. An account along these lines is consistent with a radical-pragmatic view, whereby the analysis of conjunctive and disjunctive adjectives need not be mediated by a quantifying expression. Rather, these adjectives are represented as one-dimensional; their standard type is responsible for the fact that their dimensions, the factors into which their scales can be broken, are seen as universally or existentially bound.[15]

An alternative possibility, however, is that the standard type of an adjective is less basic, and is affected by the type of dimension-binding. Assume that to count as healthy, one must be healthy in every respect $H_1 \ldots H_n$ (conjunctive dimension binding). Therefore, the standard of membership of *healthy* cannot be just slightly above the minimum of H. If such a minimum exits at all, it should correspond with the degree of entities that are slightly above the minimum in but one respect H_i. Thus, if *healthy* is interpreted conjunctively, it is classified as total or relative. Now assume that being sick in but one dimension suffices for one to count as *sick* (disjunctive dimension binding). Then, the standard of membership cannot be the maximum, for otherwise *sick* would become conjunctive, as explained above. Therefore, if *sick* is interpreted disjunctively, it is classified as partial or relative. Since all total and partial adjectives are known to also

[15] I thank François Recanati (p.c.) for this observation.

have relative interpretations (Syrett 2007; Kennedy 2007), these results are compatible with an analysis of *healthy* as total and *sick* as partial. But the connections between dimension binding and standard type are not as tight as we have seen above.

A third option is that neither standard type nor dimension binding is more basic. The analysis of conjunctive and disjunctive adjectives may be mediated by quantifying expressions over dimensions and degrees, with certain combinations of quantifiers being more difficult to use than others are. For example, combinations whereby the quantifier over degrees and the quantifier over dimensions have the same force – both are universal ($\forall H_i \in DIM(healthy)$, $\forall r \in H_i$, $f_{Hi}(x) \geq r$), or both are existential ($\exists S_i \in DIM(sick)$, $\exists r \in S_i$, $f_{Si}(x) > r$) – may be easier to process than combinations whereby the two quantifiers differ in force, one being universal and one existential. This hypothesis suggests a stronger generalization, namely that any implicit aspects of interpretation of an adjective tend to be mediated by quantification of the same force.

On this view, any implicit parameters of the interpretation of, e.g., *invisible* – degrees, parts, times, locations, etc. – are predicted to be bound by an implicit universal quantifier, whereas any implicit aspects of interpretation of *visible* are predicted to be bound by an existential quantifier. Interestingly, in support of this hypothesis, among the remaining examples with *invisible* in COCA (2010), where quantification is over times, places, etcetera, rather than over parts or degrees, **none** is negated, as shown in (24), whereas **all** of the equivalent examples with *visible* are negated, as shown in (25):

(24) a. When the sun is high in the sky, rain-caused rainbows are invisible except when you're at a high vantage point, such as a mountain.
b. …invisible except from where we'd first spotted him.
c. Their small sizes make most of them invisible except during a total eclipse.
d. … held in place by a filigree net, invisible except when the sunlight caught it.
e. … indeed almost invisible except to devotees.

(25) a. The bookshelves are **no longer** visible except when the sun shines through...
b. …far **too small to** be visible except by sophisticated measurements.
c. Green snakes are **not** visible except in the middle of the day.
d. **No** men are visible except the scurrying man.

Future research should establish how general this pattern of usage is among adjectives.

These hypotheses provide a conceptual connection between standard type and dimension binding. In addition, they are economical. Only a standard type, or alternatively only a dimension binding type, must be specified for each adjectival sense. In terms of acquisition, one cue could suffice for the acquisition of both.

In sum, section 1.3 presented two main types of hypotheses concerning predictive factors for dimension binding defaults in adjectives. By hypothesis set 2, antonym polarity is a main predictive factor, while by hypothesis set 3, standard type is a main factor. We are now ready to consider an empirical study addressing these hypotheses.

2. A corpus study of dimension binding

This section presents a corpus study of dimension binding using naturally occurring examples of adjectives modified by exception phrases. This study hinges on the fact that exception phrases are indicators of universal quantification. Section 2.1 focuses on hypothesis set 1, section 2.2 – on hypothesis set 2, and section 2.3 – on hypothesis set 3.

2.1 Hypothesis set 1: A typology based on types of logical dimension binding

2.1.1 Method

The Material consisted of naturally occurring examples of exception phrases with *except* preceded by an adjective P.

Corpus: The data was drawn from the internet using the search engine Google. Importantly, the core part of this study did not rely on Google's estimations of number of hits, which are often unreliable. Moreover, the examples for this study were scanned one by one, and repeated entries and entries clearly exhibiting deficient English competence were tracked manually and excluded from the sample. Thus, two of the main problems pertaining to the use of Google and the internet were surpassed. Lapata & Keller (2005) show in a variety of ways that, despite the many hits by non-native speakers, Google-based frequencies correlate with frequencies obtained from a carefully edited, balanced corpus, and they reliably predict Native-English judgments. Importantly, in order not to beg the research question, no examples were removed due to non-conventional usage of exception phrases or adjectives.

The searched items were of the form "P except", placed in double quotes. The first set of up to 100 hits in total per adjective was selected for the study. Negated forms such as "not P except", "wasn't P except", and "isn't P except" were additionally searched for when the need arose due to low frequency of negated forms in comparison to non-negated forms. After removal of repeated/Non-English entries, the sample consisted of a total of 1444 exception phrases preceded by each one of 18 different adjectives (n = 18, M = 80, SD = 19.5).

Items: The adjectives examined included *normal, typical, healthy, familiar, healthier, bad, sick, atypical, abnormal, different, identical, similar, good, better, intelligent, dissimilar, worse,* and *unfamiliar*. They were selected because they were suspected to be multidimensional, but, with the exception of *healthy* and *sick*, I had no clear judgment concerning their status as conjunctive, disjunctive, or other.[16] Of these 18 adjectives, 3 were marked for comparison (*worse*, *better*, and *healthier*), and 15 were unmarked. Moreover, the adjectives were divided by antonym polarity and standard type; the presentation of methods and results pertaining to these aspects is deferred to section 2.2 and 2.3, respectively.

Procedure: The examples were classified as either *dimensional* or *non-dimensional*, and as containing a *positive* or a *negative context*, by means of the following principles.

[16]The 9 uses of "in every respect except" in COCA (2010) involve mainly adjectives, verbs and preposition phrases of identity or similarity including *identical, of the common sort, like,* and *fits the ideal*.

Dimensional vs. non-dimensional uses

In dimensional uses, exception phrases operate on implicit quantifiers over dimensions. The selection of such examples was guided by three general principles. Principle I consisted of selecting exception phrases indicating quantification over dimensions (as in *healthy except for high cholesterol*), rather than over individuals, times, parts or other aspects of interpretation, as in the examples in (26).

(26) Quantification over entities, events, cases, time points, degrees, parts, etcetera:
   a. Everyone's been sick (except me--ha!)
   b. Never been sick (except a cold last year).
   c. My hair is healthy except for the front part.
   d. Healthy except {when, by, through the lens of, if }…

Principle II consisted of dismissing exception phrases that operate over dimensions if a universal or quasi-universal expression over dimensions explicitly occurred. For example, the expression *everything* in (27a) suffices to license an exception phrase. Thus, we cannot use this example as evidence for an implicit universal. Similar non-dimensional examples include quantifiers like *nothing,* and adverbs like *perfectly, totally, completely, absolutely, otherwise, never, all in all, generally* and *mostly*:

(27) a. Everything normal except for high blood pressure
   b. {Nothing, Little} abnormal except for high blood pressure
   c. The tests appeared normal except for high blood pressure
   d. {Totally, Completely, Absolutely} healthy except for failing eyesight
   e. {Otherwise, All in all} healthy except for failing eyesight

The expression *otherwise* renders (27e) equivalent to "healthy in every respect except failing eyesight." The plural *the tests* in (27c) may also suffice to license an exception phrase. Examples like this were classified as dimensional if and only if it was possible to determine based on previous context that each one of the tests in question included a variety of parameters, such that, e.g., blood pressure was but one of them.[17]

Examples were not dismissed if an explicit quantifier occurred, which was not modified by the exception phrase, as in *He had always been healthy except for an irregular heartbeat*, which is equivalent to "for any time t, he was healthy in t in every respect except heartbeat", and hence classifies as a dimensional use. In addition, examples were neither dismissed based on modification of the adjective by *very, pretty, quite, super, clearly, really, distinctly, so, that, that much, too, apparently, previously* and *basically*, nor if the adjective was preceded by verbs like *look, remain, appears, acts* or *feel*, as in (28a), nor if the adjective was used attributively, as in (28b).

[17]Blood pressure is not an organ – a concrete part of a person; rather, it is a type of health measurement. The intuition-test that I used in order to distinguish parts from dimensions was as follows. It is easy to imagine an object without one of its subparts, e.g., me without my left hand. However, it is not easy to strip an object of one of its dimensional values. It is difficult to think about me without shape, size or, blood pressure level, as the result is not an object at all. When I still had doubts, I discarded the examples.

(28) a. But like you, I find it annoying being labeled on caloric intake alone - I look healthy and feel healthy (except for being hungry, which is a drag).
b. In this population of community-dwelling, healthy (except for osteoporosis) postmenopausal women, Igf-i levels were significantly reduced in osteoporotic.

Principle III consisted of dismissing uses as non-dimensional when *except* merely marked contrast or mitigation at the clause level, as in (29a), or related to a subsequent or preceding clause, not to the adjective preceding it, as in (29b,c). (29a) has a counterfactual interpretation – the situation could be fine, but in actuality, it is not. This is not a dimensional use.[18] On (29c), *except* relates to *nothing interesting*, not to *sick.*

(29) Contrast or mitigation/ A new clause:
a. This **would** be fine, except **if** it were not for the fact that ...
b. …would never know I was sick. **Except** for being bald, I look **great**.
c. **Nothing** interesting ever happens when you're sick, **except** the occasional…

Identifying positive and negative contexts

The examples were classified further as either *negative* or *positive* depending on whether the adjective did or did not occur in a negative context, using the following principles.

(30) a. A context C is *positive* iff hits of the form 'C P except D' are roughly equivalent to $\lambda x.\ \forall Q \in DIM(P) - \{P \text{ with respect to } D\}$: x is Q & x is NOT P with respect to D.
b. A context C is *negative* iff hits of the form 'C P except D' are roughly equivalent to $\lambda x.\ \forall Q \in DIM(P) - \{P \text{ with respect to } D\}$: x is NOT Q & x is P with respect to D.

For example, in *Dan is healthy except for high cholestrol*, the adjective *healthy* is not in the scope of negation or a downard entailing expression like *hardly*.[19] In accordance, the exception phrase conveys "NOT healthy with respect to cholestrol, but healthy otherwise". Hence, on this example, *healthy* is placed in a 'positive context'. In contrast, in *Dan is not sick except for high cholestrol*, the adjective *sick* occurs under negation and therefore, the exception phrase conveys "sick with respect to cholestrol, but NOT sick otherwise." Hence, on this example, *sick* is placed in a 'negative context'. This classification criterion is further illustrated in (31a,b):

(31) a. *Near*, as in *near normal except in D,* creates a positive context, because such examples convey "(near) normal in everything, and NOT normal in D." But:
b. *Hardly*, as in *hardly normal except D,* creates a negative context, because such examples convey "(almost) NOT normal in everything and normal in D."

[18]One could expect the semantics of exception phrases to be similar across uses. Indeed, examples such as (29a) can be analyzed as involving weakening of a universal statement, but not one over dimensions. The index of evaluation forms an exception to a generalization over indices introduced by the modal *would*.
[19]A downward entailing context C reverses the direction of entailment (for any A and B s.t. A entails B but not vice versa, C(B) entails C(A), but not vice versa), e.g., *red* asymmetrically entails *colored*, but it is *not colored* that asymmetrically entails *not red*, the same with *hardly colored* vs. *hardly red*, and so on.

(32) a. There's nothing I eat that's not healthy, except maybe beer.
b. My dog does not seem to be showing signs of being sick except for blood in his poop.

Similarly, double negation creates a positive context; for instance, (32a) conveys that everything the speaker eats is *healthy*, *except maybe beer*. Conversely, (32b) conveys roughly *not sick, except for blood in poop* and hence counts as a negative context. In sum, forms like *nothing normal, never healthy, no different* and *hardly similar* count as negative, while *almost normal* counts as positive. Finally, in (29c) negation affects a different clause, not the target adjective, so this example counts as positive.

Based on these principles, a table was compiled for every adjective in the sample, with counts of the following 4 categories of usage of exception phrases:

(33) a. Dimensional uses in positive contexts (e.g., *P except Dim*)
b. Non-dimensional uses in positive contexts (e.g., *P except John/yesterday*; *perfectly P except*, etc.)
c. Dimensional uses in negative contexts (e.g., *not P except Dim*)
d. Non-dimensional uses in negative contexts (e.g., *not P except John/yesterday; not at all P except*, etc.)

The appendix includes representative examples from the table for *healthy* and *sick*.

The tables served to calculate two important values for each adjective, *conjunctivity* – |(33a)|/|(33a+b)| – the frequency of dimensional uses in positive contexts, and *disjunctivity* – |(33c)|/|(33c+d)| – the frequency of dimensional uses in negative contexts. Based on hypotheses 1a-c, and the intuition concerning the multidimensionality of the adjectives selected for this study, I expected to find dimensional uses, and my goal was to classify the adjectives into three categories. For conjunctive adjectives, the frequency of dimensional uses was predicted to be significantly larger in positive contexts than in negative ones, as stated in (34a). For disjunctive adjectives, we predicted the opposite, as stated in (34b). We define 'significantly larger' to be minimally 3 times as large. For mixed adjectives, we expected dimensional uses to occur, and be equally frequent in negative and positive contexts, as stated in (34c). [20]

(34) Hypothesis set 1:
Predicate typology based on types of dimension binding
a. Conjunctive adjectives: |(33a)|/|(33a+b)|) >> |(33c)|/|(33c+d)|.
b. Disjunctive adjectives: |(33a)|/|(33a+b)|) << |(33c)|/|(33c+d)|.
c. Mixed adjectives: |(33a)|/|(33a+b)|) ≅ |(33c)|/|(33c+d)| >> 0.

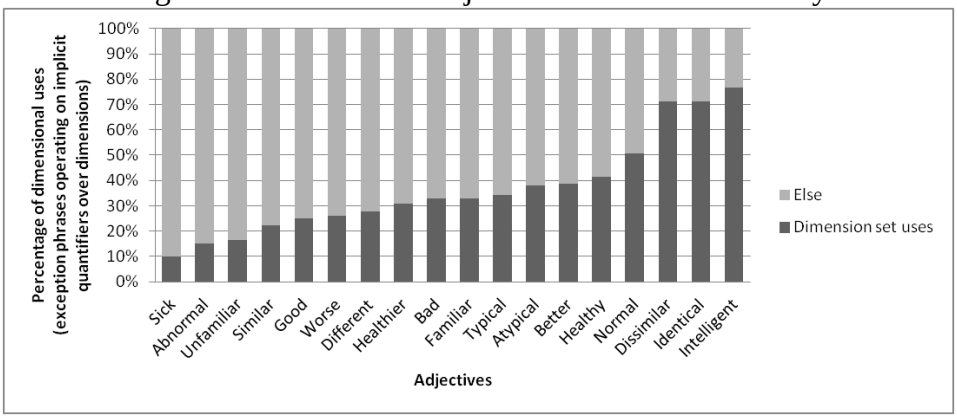
If, rather, the frequency of dimensional uses were found to approximate zero in both negative and positive contexts, this would counter hypothesis set 1a-c, namely a conjunctive, disjunctive or mixed dimension binding. Dimensions of adjectives might in principle be bound by quantifiers like *many* or by non logical operations like averaging, thereby exception phrases neither would occur in positive nor negative contexts.

[20]For a detailed explanation, see the discussion of examples (13)-(18) above.

2.1.2 Results – Hypothesis 1a-c

The predictions generally were borne out. 550 dimensional uses were found with the examined adjectives in total, which is **36.5%** of the 1444 exception phrases. In addition, dimensional uses were found with all the examined adjectives, as shown in figure 1 (M = 30.5, SD = 20, Median 23.5).

Figure 1: Evidence for Adjectival Multidimensionality



The sample included a total of 883 positive hits (M = 49, SD = 17.7) and additional 561 negative hits (M = 31; SD = 13.96). The total number of conjunctive uses, namely, dimensional uses in positive contexts was 357 out of 883 positive contexts in total (40%). The total number of disjunctive uses – dimensional uses in negative contexts – was 193 out of 561 negative contexts in total (34%).

(35) a. Conj(P) = |P Except Dim|/|P except|: Total of 40% (357/883)
b. Disj(P) = |Neg P Except Dim|/|Neg P except|: Total 34% (193/561)

Furthermore, the frequency of dimensional uses with the five adjectives in (36a) is 3-7 times higher in positive than in negative contexts. Thus, the prediction of hypothesis 1a is borne out. Some adjectives exhibit greater conjunctivity than disjunctivity values: |(33a)|/|(33a+b)|) >> |(33c)|/|(33c+d)|), supporting a default conjunctive classification.[21] Conversely, the frequency with the five adjectives in (36b) is 3-10 times higher in negative than in positive contexts. Thus, the prediction of hypothesis 1b is borne out. Some adjectives exhibit smaller conjunctivity than disjunctivity values: |(33a)|/|(33a+b)|) << |(33c)|/|(33c+d)|), supporting a default disjunctive classification.

(36) a. normal, typical, healthy, familiar, healthier
b. bad, sick, atypical, abnormal, different
c. identical, similar, good, better, intelligent, dissimilar, worse, unfamiliar

Finally, (36c) lists a third set of 8 adjectives that exhibit a mixed pattern, starting from the most conjunctive and ending with the most disjunctive. The prediction of hypothesis

[21]The data are presented in detail in Table 3, section 2.2.2 on antonym polarity.

1c is borne out. Some adjectives exhibit relatively high, but balanced conjuctivity and disjunctivity values: |(33a)|/|(33a+b)|) ≅ |(33c)|/|(33c+d)| >> 0.

2.1.3 Discussion

The fact that more than a third (36.5%) of the exception phrases preceded by an adjective operate on an implicit quantifier over dimensions supports the hypothesis that dimension binding via implicit quantifiers is available for adjectival dimensions. Moreover, the findings support a typology of adjectives based on their *default* dimension binding, conjunctive, disjunctive, and mixed. Importantly, the mixed adjectives regularly license exception phrases with a dimensional use. Hence, their dimensions are often bound by logical operations. However, no operation is set semantically to be their default. Contextual factors appear to determine whether, for example, being intelligent in but ONE dimension (say, mathematics) suffices to count as *intelligent* or ALL contextually relevant intelligence measures count.

In addition to indicating logical dimension binding defaults in adjectives modified by exception phrases, the results reflect a tendency toward logical binding in adjectives independently of the presence of an exception phrase, for otherwise, why would different adjectives systematically select different operations?

In relation to this, recall that the psychological research on linguistic concepts extensively supports an analysis of classification in nouns as based on averaged similarity (Murphy 2002; Hampton 1995, 1998). If this view is correct, we expect exception phrases not to operate on the dimensions of nouns, as those are not bound by quantifiers. An investigation of this hypothesis is outside the scope of this paper. Preliminary results of an ongoing research (Sassoon 2012a) are in line with this hypothesis, but many more nouns and exception phrases per noun have to be tested in the future. Sassoon (2011) discusses semantic and psycholinguistic differences between adjectives and nouns from the perspective of different types of dimension binding.[22]

We can now turn to the task of identifying factors that determine whether an adjective is by default conjunctive, disjunctive, or mixed. If this typology of adjectives is real, as the findings suggest, predictive factors must exist, for otherwise how can it be that children acquire this typology? Predictive factors are also needed for adults to use when 'guessing' whether a particular use of an adjective is conjunctive or disjunctive.

2.2 Hypothesis 2: Antonym polarity as a predictive factor

2.2.1 Method

The 18 adjectives divide to positive vs. negative antonyms. This division is marked morphologically in 4 pairs (*normal-abnormal, typical-atypical, similar-dissimilar,* and *familiar-unfamiliar*), and is based on robust speaker judgments in 3 pairs (*good-bad, better-worse,* and *healthy-sick*). Although judgments about the negativity of *different* are less pronounced, the pair *identical-different* was included for the purpose of cross-comparisons with *similar* and *dissimilar*, which are near synonyms, except that the

[22] For a review of neural and developmental correlates of logical ('rule-based') vs. non-logical (similarity-based) classification in invented categories see Ashby & Maddox (2005).

standards of *identical* and *dissimilar* are more extreme points on the scale than those of *similar* and *different*. With the 4 combinations *identical-different, identical-dissimilar, similar-dissimilar* and *similar-different,* all in all, the sample allowed comparisons between 10 matched pairs of a positive and a negative antonym. The classification to negative and positive antonyms was supported by a judgment survey, as follows.

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 survey consisted of 100 hits, 18 of which included the adjectives investigated in this paper. The hits were randomly ordered, and filled by 20 participants each. The instructions said: "*This questionnaire is for native English speakers only. English speakers tend to classify adjectives as either 'positive' or 'negative'. For example, adjectives like 'tall' are considered positive, while adjectives like 'short' are considered 'negative'. Adjectives like 'clean' are considered positive, while adjectives like 'dirty' are considered 'negative'. Determine to what extent the following adjective is negative or positive on a 1 (perfectly negative) to 7 (perfectly positive) scale*." The instructions of each hit were followed by one adjective and a scale for ranking.

Recall the hypothesized connections between antonymy and dimension binding:

(37) Hypothesis set 2: Antonymy as a predictive factor
  a. Antonyms differ with respect to the default force of the quantifier binding their dimensions: P is conjunctive iff P's antonym is disjunctive.
  b. Positive antonyms are conjunctive, negative ones are disjunctive.

2.2.2 Results

Considering the 1-7 polarity judgments, the mean rankings of the adjectives that were initially clasified as positive were all larger than the scale midpoint 4 (MS = 5.64, SD = .88), and the mean ranks of their negative antonyms were all below it (MS = 2.23, SD = .79). A paired t-test yielded a significant difference between the positive adjectives and their antonyms ($t = 4.81$, $df = 9$, $P < .001$). Table 2 presents the 10 pairwise comparisons of the means and standard deviations of antonyms, which were all significant ($P < .05$). Except for the pair *identical-different* ($P < .016$), the results remain significant also after Bonferroni correction, as all the p-values are smaller than .05/10 = .005.

As for dimension binding, the results suggest that antonym polarity (positive/negative) is a reliable predictor of binding type, supporting hypotheses 2a,b. The clearly conjunctive adjectives – *normal, typical, healthy, familiar,* and *healthier* – are all positive, while the clearly disjunctive adjectives – *bad, sick, atypical, abnormal,* and *different* – are all negative. Moreover, the mixed adjectives shift from positive to negative as they gradually turn from borderline conjunctive to borderline disjunctive adjectives, starting with the positive *identical, similar, good, better,* and *intelligent,* and ending with the negative *dissimilar, worse,* and *unfamiliar*. Thus, a sharp boundary between conjunctive and disjunctive adjectives can be drawn by classifying the positive adjectives as 'conjunctive' and their negative antonyms as 'disjunctive'.

Table 2: Polarity judgments

The table presents the means and standard deviations of the rankings of each adjective by 20 participants on a scale of 1 (perfectly negative) to 7 (perfectly positive) points. The rightmost columns present the statistical significance of the differences between the 10 antonym pairs.

POS P	M	SD	NEG P	M	SD	t	P <
Healthy	**6.6**	.58	Sick	**1.5**	1.12	18.08	.0001
Normal	**5.65**	1.28	Abnormal	**1.8**	.68	11.88	.0001
Typical	**4.2**	1.08	Atypical	**3.2**	.93	3.14	.0005
Similar	**4.5**	.81	Dissimilar	**2.8**	.81	6.64	.0001
Identical	**4.15**	.85	Dissimilar	**2.8**	.81	5.14	.0001
Similar	**4.5**	.81	Different	**3.4**	1.02	3.78	.0001
Identical	**4.15**	.85	Different	**3.4**	1.02	2.53	.0158
Good	**6.45**	.74	Bad	**1.1**	.0001	29.96	.0001
Familiar	**5.8**	.75	Unfamiliar	**2.6**	.97	11.67	.0001
Better	**6.3**	.78	Worse	**1.4**	.58	22.54	.0001
Intelligent	**6.7**	.90	---				
Healthier	**6.05**	1.16	---				
M	**5.64**	**.88**	**M**	**2.23**	**.79**		

Table 3: The frequency of dimensional uses of *except*

For any P, P's conjunctivity value equals the frequency of dimensional uses in positive contexts: conj(P) = |P Except Dim|/|P except|, and P's disjunctivity value equals the frequency of dimensional uses in negative contexts: Disj(P) = |Neg P Except Dim|/|Neg P except|. The statistical results at the last three lines present comparisons between each one of the three derived comparatives and the adjective it derives from.

%	POS P	Conj(P)	Disj(P)	NEG P	Conj(P)	Disj(P)	χ^2	p<	Fisher's exact test:
Adj	Healthy	**54**	11	Sick	2	**26**	47.10	.0001	.0001
	Normal	**69**	10	Abnormal	6	**20**	39.59	.0001	.0001
	Typical	**54**	9	Atypical	19	**68**	59.68	.0001	.0001
	Similar	**80**	67	Dissimilar	58	**83**	5.09	.024	.0256
	Identical	**86**	49	Dissimilar	58	**83**	14.08	.0002	.0002
	Similar	**80**	67	Different	13	**40**	13.99	.0002	.0002
	Identical	**86**	49	Different	13	**40**	21.89	.0001	.0001
	Good	**24**	21	Bad	3	**55**	30.39	.0001	.0001
	Familiar	**45**	9	Unfamiliar	15	**27**	22.86	.0001	.0001
	Intelligent	**37**	41	---					
Comp.	Better	**25**	25	Worse	20	**32**	1.38	.2407	.3188
	Healthier	**35**	9	---			.22	.6402	.8014
	Better	**25**	25	---			.11	.7455	.8379
	---			Worse	20	**32**	18.37	.0001	.0001
	M	**56.3**	**30.6**	**M**	**20.7**	**47.4**			

Table 3 lists the conjunctivity and disjunctivity values. A Chi-square test of independence for the 10 antonym pairs yields that the association between antonym polarity (negative/positive adjectives) and disjunctive vs. conjunctive binding (frequency of dimensional uses in negative vs. positive contexts) is statistically significant ($\chi 2 = 38.64$, df = 12, $p < .00013$). This result obtains when testing each

antonym pair separately, except for the pair of comparatives *better* vs. *worse*, as the rightmost columns of table 3 show. A chi-square probability of up to .05 is a justification for rejecting the null hypothesis that antonym-polarity is independent of dimension-binding type. Except for *similar-dissimilar*, the results remain significant also after Bonferroni correction, as all the p-values are smaller than .05/10 = .005.

The clustering of positive antonymy with conjunctivity and negative antonymy with disjunctivity is a post-hoc discovery. It is therefore useful to test whether this clustering predictably generalizes to other multidimensional adjectives. A 2x2 two-factor mixed ANOVA with positive vs. negative antonym polarity as a between-item variable, and frequency of dimensional uses in positive vs. negative contexts as a repeated measure, yields a significant interaction between antonym polarity and conjunctive vs. disjunctive dimension binding ($F = 51.92$, $P < .0001$). As Figure 2 shows, the conjunctivity values of positive adjectives in the sample are equal or higher than their disjunctivity values (M = .51 SD = .22 vs. M = .25, SD = .21), whereas those of negative adjectives are all smaller than their disjunctivity values (M = .17, SD = .18, vs. M = .44; SD = .23). In addition, the conjunctivity values are higher in positive than in negative adjectives (M = .51, SD = .22 vs. M = .17, SD = .18, resp.), whereas the disjunctivity values are generally lower (M = .25, SD = .21 vs. M = .44, SD = .23.)

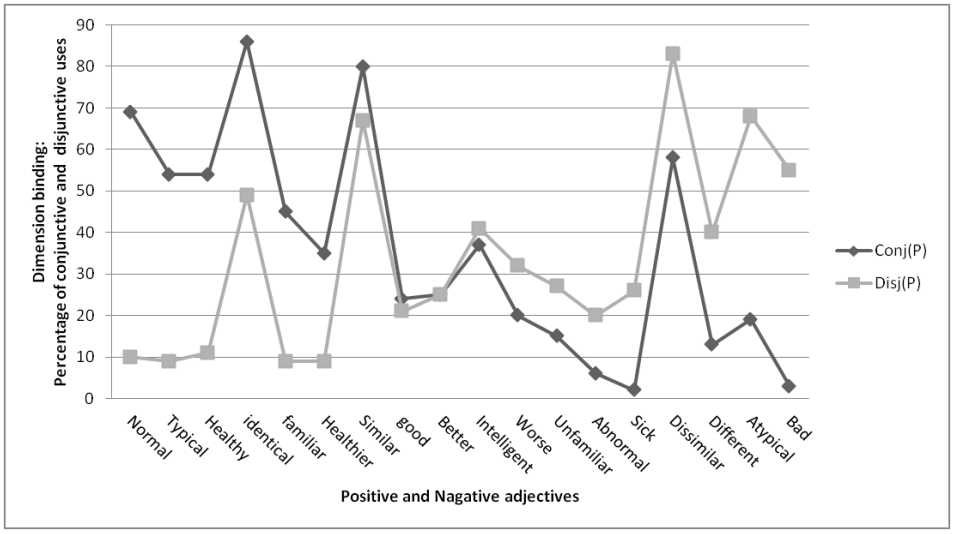


Figure 2: Interaction between dimension binding and antonym polarity

The frequency of dimensional uses has been compared in four correlated samples: (i) positive adjectives in positive contexts (conjunctivity in positive antonyms, as in *healthy except*); (ii) positive adjectives in negative contexts (disjunctivity in positive antonyms, as in *not healthy except*); (iii) negative adjectives in positive contexts (conjunctivity in negative antonyms, as in *sick except*); and (iv) negative adjectives in negative contexts (disjunctivity in negative antonyms, as in *not sick except*). A non-parametric Friedman test for the 10 matched pairs in table 3 yields significant results, meaning that the four samples generally are different ($\chi^2 = 20.1$, $P = .0002$).[23] A non-parametric Wilcoxon signed-ranks test for the significance of the difference between the

[23] A non-parametric analysis of variance does not assume normal distributions.

distributions of two samples of 10 matched pairs shows that only the differences of interest contribute to the significance value, including in particular positive adjectives in positive vs. negative contexts (W = 55, z = 2.78, P = .0054), negative adjectives in positive vs. negative contexts (W = -55, z = -2.78, P = .0054), and positive vs. negative adjectives in positive contexts (W = 55, z = 2.78, P = .0054). The fourth difference of interest between positive and negative adjectives in negative contexts only approaches significance (W = -37, z = -1.86, 2-tailed P = .0629, 1-tailed P = .0314). The outlier is *different* which is less disjunctive than both *similar* and *identical*.

Frequency of dimensional uses is neither significantly lower in negative than in positive contexts (M = 35.83, SD = 26. vs. M = 33.44, SD = 22.92; t-test for n = 18, yields t = .309, P = .76), nor in negative than in positive antonyms (M = 38, SD = 24.53. vs. M = 30.44, SD = 24.1; t = .93, P = .36).

Finally, let an adjective's *normalized conjunctivity* be its conjunctivity value divided by the sum of its conjunctivity and disjunctivity values. This combined index represents the frequency of conjunctive interpretations, given either conjunctive or disjunctive interpretations. The correlation between the 1 to 7 polarity judgments and *normalized conjunctivity* for the 18 adjectives is moderate to strong (r = .75, t = 4.52, P < .0004; the non-parametric Spearman rank order correlation yields r_s = .7, t = 3.69, P < .0012).

2.2.3 Discussion

The results in the previous subsection are suggestive of the following generalizations. In positive adjectives conjunctivity is predictably higher than disjunctivity, whereas in negative adjectives it is predictably lower. Also, conjunctivity is predictably higher in positive than in negative antonyms, whereas we can say that disjunctivity is predictably lower with an almost, but not quite high enough level of confidence (P < .063). This last fact may be driven by tendency of speakers to avoid double negation, as in, e.g., *not abnormal* which, given a logical-negation theory of antonymy, is seen as conveying "not not normal".

The findings pertaining to antonym polarity as a predictive factor are surprisingly clear-cut. These findings support an analysis of negative antonyms as negations of their positive counterparts (cf. Heim 2006, 2008; Büring 2007), for otherwise why would the force of quantifier over dimensions systematically vary in antonym pairs? These findings are preliminary, but suggestive of the importance of future inquiry into possible interactions between antonymy and quantifier force in multidimensional adjectives.

Hence, compositional processes seem to affect dimension binding. Positive adjectives are associated with a default quantifier, while negative ones inherit it, so to speak, and contribute a negation operator that switches the force of the quantifier:

(38) a. sick ⇔ ¬healthy ⇔
b. $\lambda x.\neg\forall Q\in DIM(healthy)$: Q(x) ⇔
c. $\lambda x.\exists Q\in DIM(healthy)$: ¬Q(x)

Notice, however, that for this to work, negation in (38) should stand for normal sentential negation, not for the slightly different operator – adjectival negation – used by

Heim (2006, 2008) and Büring (2007).[24] This difference is problematic if adjectival negation is crucial to account for denotation gaps, namely, the fact that entities may fall under *not-healthy* without falling under *sick*; entities may be neither *healthy with respect to blood pressure*, nor *sick with respect blood pressure*, etc. (Rotstein & Winter 2005). However, Solt & Gotzner (2010) show in a series of experiments that sentential negation creates denotation gaps too; for example, entities may be judged neither *tall* nor *not tall*. The use of antonyms like *short* differs from the use of negated positives like *not tall* only insofar as it triggers interpretations with larger gaps. The difference between, e.g., *not healthy* and *sick* may therefore be quantitative, not qualitative.[25]

Interestingly, both the COCA data (cf. 1.3.1) and the Google data suggest that variance in interpretation correlates with quantifier type. For example, the data supports a default conjunctive analysis of *typical* and disjunctive analysis of *atypical*. My impression is that the apparent counterexamples to these analyses systematically belong to secondary interpretations of these adjectives. For example, (39) is an exceptional conjunctive use of *atypical*. However, in scientific contexts *atypical* is used to convey a non-default interpretation "belongs to an atypical group", which is, apparently, conjunctive. For a potential subject to belong to an atypical group in a scientific research (say, specific language impairment; aphasia, etc.), he or she should ideally exhibit many if not **all** of the symptoms defining that group.

(39) Patient 4 was atypical except for the high-pitched voice.

Similarly, as the appendix illustrates, exceptional uses of *healthy* as disjunctive and *sick* as conjunctive are more abstract, metaphoric, or simply different from their default uses. For instance, the exceptional dimensional use of *sick* in a positive context exemplifies a novel usage, whereby *sick* conveys *cool* (Jessica Olsen, p.c.). I leave it for future research to determine how far variance in interpretation can help in predicting dimension binding, in particular in mixed adjectives, for example, *good*. Good fit will support an account of any adjective as associated with both universal and existential interpretations, and of its positivity ranking as reflecting the dominance (relative frequency) of the former compared to the latter. On such an account, accommodation of a quantifier over dimensions within context amounts to activation of a certain interpretation and suppression of others. Exception phrases like other existential and universal markers (*perfectly, somewhat*, etc.) may form cues for the selection of an appropriate interpretation (e.g., *cool* for *sick*).

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[24]Heim (2008) analyses the interpretation of adjectives like *tall* as relational, $\lambda x{\in}D_x.\ \lambda r{\in}D_r.\ f_{tall,c}(x) \geq r$, and decomposes their negative antonyms into their direct antonym and a negative particle *little* denoting the adjectival negation $\lambda A{\in}D_{<r,xt>}\lambda x{\in}D_x.\lambda r{\in}D_r.\ \neg A(x)(r)$. Thus, the interpretation of, e.g., *short* ⇔ 'little tall' reduces to $\lambda x{\in}D_x.\ \lambda r{\in}D_r.\ f_{tall,c}(x) < r$. On an analysis of *tall* as denoting the function $f_{tall,c}$ in each index c, *little* has to denote a function-reversal modifier such as, $\lambda A{\in}D_{xr}\lambda x{\in}D_x.\ r_A - A(x)$, for some constant $r_A{\in}D_r$. On this account, the resulting degree function of *short*, $\lambda x{\in}D_x.\ r_{short} - f_{tall,c}(x)$, is linearly reversed in comparison with *tall*'s (for a detailed discussion see Sassoon 2010).

[25]Sassoon (2012a) observes that association of positive adjectives with mappings $f_{dim(P)}$ of entities x to the number of respects true of them, $f_{dim(P)}(x) = |\{Q{\in}DIM(P)\colon Q(x)\}|$, together with a maximum standard, |DIM(P)| or 0, predicts universal truth conditions, x is P is true iff e.g. $|\{Q{\in}DIM(P)\colon Q(x)\}| = |DIM(P)|$). An account of negative antonyms, NegP, via adjectival negation with $r_{NegP} = |DIM(P)|$ and a minimum standard predicts existential truth conditions: x is NegP is true iff $(|DIM(P)| - |\{Q{\in}DIM(P)\colon Q(x)\}|) > 0$.

The basis for antonym polarity judgments is not straightforward and uncontroversial. Antonyms impose reversed entity orderings. For example, intuitively, entity orderings imposed by negative adjectives like *short* are reversed in comparison with those of their positive base *tall*, as illustrated by the robust intuition that for any two entities x and y, x is taller than y iff y is shorter than x. Besides this general observation, researchers in a variety of disciplines have proposed different tests as criteria for negative vs. positive antonymy, resulting in only partially overlapping sets, and many exceptions to each criterion (for a review see Lehrer 1985 and Sassoon 2010; for a psycholinguistic characterization see Giora 2006). Future research should determine precisely which notion of negative antonymy is indicative of dimension-binding type.

The present results contribute to our understanding of this problem in highlighting a new potential generalization. Polarity judgments seem to relate to slightly different phenomena in dimensional vs. multidimensional adjectives. In dimensional adjectives, like *tall* vs. *short*, positivity relates to the existence of a property, e.g., much *height*, whereas negativity relates to the lack of much of that property. However, in multidimensional adjectives like *healthy* and *sick*, positivity seems to relate to a generalization – membership under EVERY dimensional property, whereas negativity relates to the existence of a counterexample – failure to reach the membership standard of SOME dimension.

Two criteria for antonym polarity are of particular interest – the morphological criterion (as in *typical* vs. *atypical*), and the qualitative criterion (as in *bad* vs. *good*). Plausibly, some morphologically negative adjectives could be qualitatively positive. A question for the future is whether such adjectives are conjunctive or disjunctive. This question can be dealt with by choosing a sample of adjectives whose status as negative or positive differs depending on the criterion you choose for classification. A related question is whether adjectives with different antonymy morphemes have different dimension binding defaults.

Finally, additional morpho-syntactically complex expressions with multidimensional adjectives should be investigated in the future. Consider, for example, the comparative morphemes *more* and *-er* (as in *taller*). On the standard analysis, the interpretation of these morphemes is equivalent to a function from the interpretation of a predicate P, and two entities x and y, to truth iff for some degree on P's scale, x is P to at least that degree, but y is not (Klein 1980). Considering this interpretation, it is easy to see that the comparative morpheme can only select as an argument one predicate interpretation – one dimensional scale – at a time. Therefore, an important open question concerns comparatives derived from multidimensional adjectives; e.g., given that x can be healthier than y in one respect, but not in another, what does the bare comparative form *healthier* mean? Similar issues arise concerning, for example, *healthiest, the least beautiful, very healthy, too healthy*, and so forth.

If compositionality plays a systematic role, we may expect the dimensions of, e.g., comparative and superlative adjectives to be bound by the default operation of their base adjectives. On this analysis, *healthier* is interpreted as conveying "for every respect Q, healthier with respect to Q", $\lambda y \lambda x. \forall Q \in DIM(healthy)$: er(healthy(x,Q), healthy(y,Q)).[26]

[26]Here again, context restrictions may play a role. On a scenario whereby a man has high blood pressure, while his dying wife has normal blood pressure, intuitively, the husband is healthier despite of him doing

Thus, the conjunctivity and disjunctivity values of derived comparatives should resemble those of the adjectives from which they derive. The present study included but three comparatives – *healthier, better,* and *worse*. The prediction was borne out: *healthy* is conjunctive, and so is *healthier*; *good* and *better* are both mixed, and *bad* and *worse* are both disjunctive.[27] Considering the last three lines of table 3, the non-significance of the differences between *healthy* and *healthier* and between *good* and *better* are in line with the hypothesis that comparatives inherit the binding type of the adjective they derive from. The difference between *bad* and *worse* is significant because *bad* is more extremely disjunctive than *worse*. Notice that to accommodate situations in which entities are, e.g., healthier in one respect but not in another, comparatives of conjunctive adjectives may tend to be weaker, e.g. *healthier* may convey "healthier in MOST respects", "healthier on average", or even "healthier in MORE respects". For the same reason, comparatives of disjunctive adjectives may be interpreted as stronger than merely disjunctive, e.g., *worse* may convey "worse in MOST respects" or "on average", rather than "in some respect". A systematic test of comparatives awaits future research.

To conclude, the study of antonym polarity supported an account whereby compositional processes affect the force of implicit quantifiers over dimensions. Many questions for the future arise, pertaining to the study of gradability and comparison. One important issue consists of the implications of the quantifier over dimensions in the interpretation of adjectives for the analysis of comparison statements. We now turn to the last part of our study – a test of hypothesis-set 3. Our sample allows for a preliminary investigation of the question whether total (maximum standard) and partial (minimum standard) adjectives correspond with conjunctive and disjunctive ones.

2.3 Hypothesis set 3: Standard type as a predictive factor

2.3.1 Method

Partial adjectives have a minimum standard, for example, one stain suffices for a shirt to count as *dirty*. Total adjectives have a maximum standard, e.g., to count as *clean* a shirt has to be completely free of dirt (maximally clean). The standard of relative adjectives like *tall* is a midpoint on the adjective's scale, which varies with context. The status of the 18 adjectives in the sample was determined using two different methods.

First, standard types were determined based on established tests of inference patterns sensitive to standard type (Kennedy & McNally 2005; Rotstein & Winter 2005; Kennedy 2007). This classification was based on data from the above cited literature, and was confirmed by judgments of at least two informants per adjective.[28]

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less well in one respect. This intuition is consistent with a quantificational analysis, granting that blood pressure does not count as a relevant in the context (Lewis 1979, von Fintel 1994).

[27] *Sicker* was excluded from the sample of the study because it is infrequent and rarely co-occurs with *except*; the data was too scarce to assess frequency of exception phrases operating on dimensions.

[28] The tests used to determine standard type (Winter & Rothstein 2005; Kennedy & McNally 2005):
First, in partial (minimum standard) adjectives, unlike total (maximum standard) adjectives and relative (mid-point-standard) adjectives, any non-zero degree in P entails P-hood. Thus, (ia), but not (ib-c), intuitively is judged to be a contradiction.

(i)a. #The door is not open, but it is still ajar [contradiction]
b. The door is not closed, but it is almost closed [No contradiction]

Second, Google searches of the internet were conducted for each adjective preceded by four modifiers, including two 'maximizers' (*entirely* and *perfectly*) and two 'minimizers' (*slightly* and *partially*), to estimate the frequency of an adjective's total vs. partial interpretations, respectively (cf. Rotstein & Winter 2005 and Kennedy & McNally 2005). If, for example, adjectives are total, then modification by, e.g., *perfectly* might appear redundant, but in actuality, the frequency of such modification helps speakers to identify total adjectives. Felicity judgments, patterns of usage revealed in corpora, and experimental research of acquisition support this view (Syrett 2007; Tribushinina 2010a). For example, eyetracking reveals that upon hearing pseudo-adjectives modified by maximizers like *completely*, children tend to shift their attention from potential relative interpretations to total ones (Syrett 2007). Moreover, Google's estimations of the frequency of modifiers is precisely the right thing to compare to the Google-based conjunctive vs. disjunctive measurements.

All items were put in double quotes (as in "perfectly healthy") and were searched in the same day, using the same computer.[29] The hypothesized connections between standard type and dimension binding are as follows:

(40) Hypothesis set 3: Standard type as a predictive factor
   a. A is conjunctive if and only if A is total (has a maximum standard).
   b. A is disjunctive if and only if A is partial (has a minimum standard).
   c. A is mixed (has conjunctive and disjunctive uses, which are equally frequent) iff A is predominantly relative (neither total not partial).

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c. Sam is not tall but his height is normal for his age [No contradiction]

Second, in total (maximum standard) adjectives, unlike partial and relative adjectives, P-hood entails maximum degree in P. Thus, (iib), but not (iia,c), intuitively is judged to be contradiction.

(ii)a.The door is open, but it is not completely open [No contradiction]
b. #The door is closed, but it is not completely closed [Contradiction]
c. Sam is tall but he could be taller [No contradiction]

Third, mid-point modifiers like *half* or *partially* entail P-hood in partial adjectives and non-P-hood in total adjectives (iiia-b). They entail neither in relative adjectives (iiic).

(iii)a. The door is half open ⇒ The door is open.
b. The door is half closed ⇒ The door is not closed.
c. The tree is half tall ¬⇒ The tree is (not) tall.

Third,

Fourth, total and partial antonyms tend to be complementary, while in relative adjectives entities may easily fall under neither P nor P's antonym, as illustrated in (iva) vs. (ivb), respectively.

(iv)a. The door is not closed ⇒ The door is open.
b. Sam is not short ¬⇒ Sam is tall.

Fifth, *x is more P than y* entails that *x is P* in partial adjectives (va), that *y is not P* in total adjectives (vb), and neither in relative adjectives (vc):

(v)a. The door is more open than the window ⇒ The door is open.
b. The door is more closed than the window ⇒ The window is not closed.
c. Rod A is longer than Rod B ¬⇒ Rod A is long/ Rod B is not long.

[29]The frequency of modifiers characteristic of relative adjectives (*very, extremely, really, relatively* and *too*, cf. Syrett 2007) cannot indicate relativity reliably because they frequently modify total and partial adjectives. Syrett (2007), for example, relates to their distribution as 'non-restricted'.

2.3.2 Results

The standard tests of inferences (Rotstein & Winter 2005; Kennedy & McNally 2005) yield a classification by standard type that cuts across antonym polarity. Thus, statistically significant differences are unlikely. Illustrating briefly, the 7 total adjectives – *unfamiliar, normal, typical, healthy, identical, good,* and *dissimilar* – have higher normalized conjunctivity values than the 10 partial ones – *familiar, similar, abnormal, atypical, sick, different, bad, healthier, worse,* and *better* (M = .64, SD = .22 vs. M = .39, SD = .28), but the result of a non-paired t-test is almost but not quite significant (t = 2.067; df = 15; P = .056); the situation worsens upon exclusion of the comparatives.

As for modifier distribution as a measure of standard type, the second column from the left of table 4 presents Google's estimation of the number of occurrences of each adjective in the internet in thousands ('frequency'). The third column presents Google's estimation of the frequency of occurrence of each adjective preceded by *entirely*, divided by the adjective's frequency. The subsequent columns present the data for the other modifiers. Figure 3 presents the relative size of the frequencies of partial (*slightly* and *partially*) vs. total (*perfectly* and *entirely*) modifications for each adjective. For example, the preference for partial- as opposed to total-modification is greatest for *atypical*.[30]

Table 4: Modifier distribution

The table presents the percent of Google hits (July 2010) with adjectives preceded by modifiers indicative of total (*entirely* and *perfectly*), and partial (*slightly* and *partially*) interpretations. The *normalized Totality index* presents the frequency of total modifiers among hits with either total or partial modification.

	FREQUENCY IN THOUSANDS	ENTIRELY %	PERFECTLY %	SLIGHTLY %	PARTIALLY %	Normalized Totality %
WORSE	93,600	0.01	0.00	0.35	0.00	**2**
BETTER	826,000	0.00	0.00	0.28	0.00	**3**
HEALTHIER	32,800	0.01	0.00	0.25	0.00	**3**
SICKER	1,100	0.00	0.00	0.18	0.00	**4**
ATYPICAL	5,020	0.08	0.01	0.35	0.01	**19**
ABNORMAL	21,300	0.19	0.03	0.41	0.00	**35**
DIFFERENT	791,000	0.63	0.01	1.02	0.00	**38**
SICK	111,000	0.02	0.01	0.03	0.00	**49**
SIMILAR	665,000	0.01	0.01	0.01	0.00	**50**
FAMILIAR	128,000	0.04	0.04	0.03	0.01	**68**
INTELLIGENT	69,500	0.01	0.08	0.03	0.00	**71**
BAD	627,000	0.01	0.02	0.01	0.00	**73**
UNFAMILIAR	10,100	1.11	0.00	0.20	0.00	**85**
HEALTHY	172,000	0.06	0.26	0.05	0.00	**87**
DISSIMILAR	3,330	3.45	0.07	0.42	0.01	**89**
IDENTICAL	50,400	0.09	0.15	0.00	0.03	**89**
GOOD	1,720,000	0.00	0.11	0.01	0.00	**90**
TYPICAL	107,000	0.06	0.03	0.01	0.00	**92**
NORMAL	444,000	0.03	0.34	0.01	0.00	**98**

[30]The figure does not represent whether relatively many or few counts of *atypical* are preceded by a modifier at all, whether partial or other.

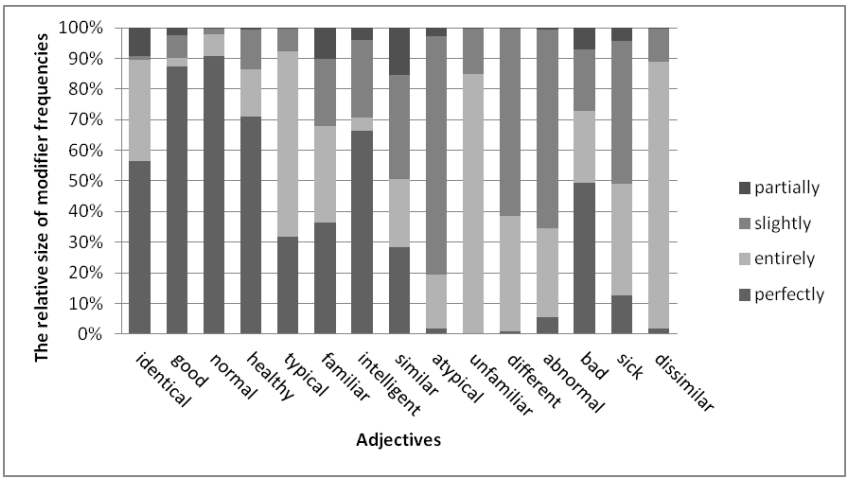

Figure 3: Modifier distribution

The relative size of the frequencies of partial (*slightly* and *partially*) and total (*perfectly* and *entirely*) modification in each adjective.

Let an adjective's *totality* value be the frequency at which it occurs modified by *perfectly* and *entirely*, namely, |perfectly A|/|A| + |entirely A|/|A|; this index, arguably, represents the relative frequency of total interpretation in different adjectives. Similarly, let an adjective's *partiality* value be the frequency at which it occurs modified by *slightly* and *partially* – |slightly A|/|A| + |partially A|/|A|; this index represents the relative frequency of partial interpretation in different adjectives. A combination of these two values, an adjective's *normalized totality*, is its totality value divided by the sum of its totality and partiality values. This index represents the frequency of a total interpretation, given a non-relative (total or partial) interpretation. Based on hypotheses 3a-b whereby total adjectives are conjunctive and partial ones are disjunctive, we expect to find a correlation between normalized totality and normalized conjunctivity.

Including the three comparative adjectives, the correlation is r = .31. Table 4 clearly indicates that the comparative adjectives are by no means total, regardless of whether they tend more toward a conjunctive or a disjunctive interpretation (possibly because dimensions of comparatives tend to be bound by the default operation of the adjectives from which they derive, cf. 2.2.3). However, in non-comparative adjectives, the correlation is moderate to strong (n = 15, r = .62, P < .013; the Spearman rank-order correlation yields r_S = .7, t = 3.5, df = 13, P < .004.) The modifier *perfectly* and the conjunctivity scores are the main contributors to this correlation. The correlation between conjunctivity and the frequency of modification by *perfectly* is moderate to strong (n = 15, r = .66, P < .008; Spearman correlation yields r_S = .77, t = 4.36, P < .0008.)[31] Tests of correlations with other modifiers and with disjunctivity did not yield significant results, and were affected by exclusion or inclusion of deviant cases.[32]

[31]Similarly, normalized conjunctivity correlates with frequency of co-occurrence with *perfectly* (n = 15, r = .63, P < .012 and r_S = .65, t = 3. 05, P < .009). By contrast a weak negative corralation with disjunctivity does not reach significance (r = -.24, P = .4; is r_S = -.08, t = -.3, P = .77).

[32] -Entirely × conjunctivity: r = .08, P < 0.78 (without *dissimilar* r = -.323, P < .26);
-Entirely × disjunctivity: r = .49, P < .06 (without *dissimilar* r = -.034, P = 0.9);
-Slightly × conjunctivity: r = -.361, P < .19 (without *different* r = -0.3, P < .3);
-Slightly × disjunctivity: r = .26, P < .35 (without *different* r = .4, P < .16);

Finally, since relative adjectives are infrequent with both total and partial modifiers, the maximum frequency of an adjective with the total and partial modifiers may inversely indicate its relativity. Moreover, mixed adjectives are characterized by a small difference between their conjunctivity and disjunctivity values. Thus, based on hypothesis 3c whereby relative adjectives are mixed we expect a correlation between the maximum frequency of modification of an adjective by the four modifiers and the difference between its conjunctivity and disjunctivity values. This expectation was not confirmed ($r = -.11$, $P = .7$; $t = -0.41$; $r_s = .02$, $P = .9$, $t = .08$). Hence, we failed to confirm the prediction of hypothesis 3c.

2.3.3 Discussion

The frequencies of modifiers in table 4 are based on estimations by Google, which are predictably affected by noise. That being said, for the most part, the figures seem to reliably represent intuitions of English speakers. Moreover, the correlations discussed above support the hypothesis that frequent modification by *perfectly* is a cue for default conjunctive dimension binding. Assuming that *perfectly* is also a cue of a maximum standard, there is a connection between standard type and dimension binding type.

To establish this connection more strongly in the future, many other adjectives and modifiers indicative of standard type have to be investigated, such as *almost*, *completely*, *totally* and *somewhat*. Modification of negative adjectives deserves special attention, as the main non-comparative outliers are negative adjectives, in particular, *bad*, *sick*, *dissimilar* and *unfamiliar*. Non-total negative adjectives appear to license maximizers like *entirely*. Thus, in negative antonyms we find discrepancies between classification by inference tests (Kennedy & McNally 2005) and by modifier-distribution (see also Sauerland & Stateva 2010; Tribushinina 2010b). For example, on the one hand, intuitively, the adjective *bad* is partial, since, for example, *#the paper is not bad, but it is somewhat bad* is odd. In addition, *my paper is worse than yours* implies that my paper is bad, and does not imply that your paper is not bad; rather to the contrary, it implies that it is bad too. These judgments suggest that *bad* is partial. On the other hand, intuitively, *entirely bad* and *perfectly bad* are grammatical, while *slightly bad* and *partially bad* are odd. These judgments are reliably reflected by Google's estimations in that, of these two pairs of modifiers, the former co-occurs with *bad* more often than the latter.[33]

These observations suggest that modifier distribution is affected by a variety of factors beyond mere standard type as refleced by inference tests pertaining to maximum vs. minimum degrees. One factior may be the frequency of universal vs. existential quantification over parts, or other aspects of interpretation. An alternative hypothesis to consider for the future is, therefore, that in multidimensional adjectives the distribution

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-Partially × conjunctivity: $r = .47$, $P < .079$ (without *identical* $r = .135$, $P < 0.65$);

-Partially × disjunctivity: $r = .33$, $P < .23$ (without *identical* $r = .405$, $P < .15$).

[33]Apparently, *perfectly* is almost entirely incompatible with negative adjectives, while *entirely* is perfectly compatible. As observed by Tribushinina (2009), in a variety of languages including, for example, Russian, maximizers such as *entirely* (*sovsem*) combine with relative adjectives, and especially negative ones. Also, *different* is cited by Syrett (2007) as among the most frequent adjectives occurring with total modifiers. Finally, the scales of, e.g., *bad* and *different* are intuitively lower-closed, but upper open (lacking a maximum), meaning that licensing of maximizers is unlikely to be explained by virtue of a doubly-closed scale, whereby a maximum exists that does not function as a standard (cf. Kennedy 2007).

of modifiers like *perfectly* indicates dimension binding, independently of standard type. This alternative explanation is supported by the existence of groups of near synonyms and antonyms, like *identical, similar, different, dissimilar,* and *excellent, good, bad, terrible*. If positive adjectives generally are conjunctive, and negative ones generally are disjunctive, but they may have either type of standard, it is useful to have several near synonyms and near antonyms differing in whether their standard is an extremely low point on the given scale (e.g., *dissimilar, terrible*), an extremely high point (*identical, excellent*), or some midpoint on the scale, which again, either may be low (*different, bad*) or high (*similar, good*). These data speak against the general hypothesis that a default quantificational force is associated uniformly with several aspects of a given adjectival interpretation. Conclusions on this point await future research.

To conclude, the results suggest that modifiers like *perfectly* cue conjunctive dimension binding, and that, therefore, evidence for dimension binding defaults exist, which may help children to acquire the interpretation of multidimensional adjectives. If *perfectly* is also a reliable marker of totality, then this result suggests that standard type and dimension binding are connected.

3. General discussion and concluding remarks

The reported study investigated approximately 1,500 examples of exception phrases modifying adjectives, one by one. Because of the difficulty involved in doing so, the sample size is limited in terms of number and types of adjectives considered. It is too small for the results to generalize conclusively. Still, the results are suggestive of interesting generalizations along the lines of hypotheses 1-3. Thus, the fruitfulness of the experimental method calls for future research into the problems under discussion, with the goal of determining how wide ranging the generalizations are.

The most important results suggest that positive and negative adjectives are different both with respect to conjunctivity and with respect to disjunctivity. More precisely, positive adjectives are more conjunctive than disjunctive, and more conjunctive than their negative antonyms, while negative adjectives are more disjunctive than conjunctive, and they tend to be more disjunctive than their positive antonyms.

Furthermore, in adjectives unmarked for comparison, a moderate to high correlation exists between conjunctivity and frequency of modification by *perfectly.* Future research should examine a larger sample of adjectives and relevant degree modifiers, systematically divided into all possible combinations of antonym polarity and standard type. Also, a way to improve the precision of the results could be by disambiguating, i.e. separating different interpretations of adjectives. The data from COCA (Davies 2010) suggest that the force of explicitly used quantifiers over dimensions is a good predictor of the force of implicitly accommodated ones. Google counts with explicit quantification can be examined systematically to support or refute this hypothesis in the future. Finally, acceptability judgments of sentences with exception phrases operating over adjectival dimensions should also reflect dimension binding defaults. For a first study supporting this claim see Sassoon (2012).

In conclusion, this paper presented a new systematic way to uncover rules and strategies that govern accommodation of implicit operators. The results deepen our understanding of multidimensional adjectives, antonymy and degree modification.

Future work should strengthen the empirical basis of the research of implicit operators in the interpretation of adjectives, and aim toward a formulation of a formal semantic-pragmatic theory.

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Appendix

Table 5: Exception phrases co-occurring with *healthy* and *sick*

In dimensional uses, expressions relating to dimensions are written in capital letters. In other examples, expressions are written in capital letters if they explicitly refer to a quantifier or a domain for the exception phrase to operate on (individuals, parts, times, etc.)

***HEALTHY* IN POSITIVE CONTEXT**		***HEALTHY* IN NEGATIVE CONTEXTS**	
DIMENSION USES	**OTHER USES**	**DIMENSION USES**	**OTHER USES**
people are told that they are healthy, except for. their OBESITY.	She has OTHERWISE been relatively healthy except for a long history of asthma.	working like a dog this weekend as I do every weekend. 24 hours in 2 days. Not healthy, excpt FOR MY BANK ACCOUNT	… that the infant was not healthy except [= IN ADDITION TO] for the regurgitation or vomiting
...I am a 64-year-old man, quite healthy except for high BLOOD PRESSURE, which was diagnosed last year. My doctor gave me Hydro-Diuril, which was only partly ...	I have a 2yr old ginger tom who is PERFECTLY healthy, except his gums seem to have dark brown patches on them? -	confusion is not healthy except that IT WILL ULTIMATELY LEAD TO THE TRUTH	anything above that is overweight and NOT HEALTHY. EXCEPT in a few medical circumstances, there is no excuse for being overweight
I gave a kidney, some years ago (I'm 59 and basically healthy, except for TOO MUCH FAT, no gall bladder and colestherol in the liver, a few things more not ...	She took no medications and stated that she was GENERALLY healthy, except for minor chronic anemia. She exercised frequently and denied use of tobacco or ...	It should be noted that many affluent neighborhoods, also, are not healthy, except for THEIR ECONOMIC CONDITION.	nearly all estrogen given in medicine is not healthy, except IN CASES WHERE a woman has had her ovaries removed
A total of 54 patients (mean age 11.5 years, median 11, standard deviation ± 4.52) were healthy except for NEUROPATHIC BLADDER due to	The skin over the encephalocele was BY AND LARGE healthy, except FOR A SMALL AREA in the center where there was skin erosion. ...		Although, MOST VEGETARIANS I know (and there are a lot in this area) never seem to look very healthy, except FOR THE FEW that regularly take many vitamin ...
I am healthy except for high CHOLESTEROL, high BLOOD PRESSURE, and ...	EVERYBODY in the dining table look healthy except uncle		noth healthy, except THE GREEN TEA PART
I worked at the infamous "bomb" plant for 31 years and am still healthy except for AN UNRELATED HEART PROBLEM.	Mental health was not considered as part of being healthy except BY A FEW of the oldest children.		Unless you are a child, it is NOBODY else's job to keep you healthy except yours.
I'm healthy except for DIABETES.	A family of four was healthy, except FOR ONE SON, who had asthma.		too much of ANYTHING is not healthy. except money
I was 26 and pretty healthy except for SOME MILD	MOSTLY eating healthy except FOR ONE DAY A		MOST food here is obviously not healthy,

ASTHMA.	WEEK WHEN we eat out		except for the salads.
a brother to the proband, was healthy except for INFERTILITY;	EVERY YEAR he's been healthy except this pass year.		There's NOTHING I eat that's not healthy…except maybe beer
***SICK* IN POSITIVE CONTEXT**		***SICK* IN NEGATIVE CONTEXTS**	
DIMENSION USES	**OTHER USES**	**DIMENSION USES**	**OTHER USES**
I think its sick, except A FEW THINGS. I have never heard of those subs, id swap em out for JL Subs and Amps..id get rid of the body kit on the front, and maybe change the rims.. but if it was cheap for me to buy that id definitely buy it	he said Edna was home and they were ALL sick except HER AND DAN.	Haven't really been sick except maybe A COLD	We were all very seasick indeed for the first two days but after that NONE OF US WERE AT ALL sick, except Gen.
	There's been so much bad news on the health care front for working Americans that it makes us SICK. EXCEPT, if you do get sick you probably can't afford it.	He has not really been seriously sick except for HIS EARS. The ears problem runs in both my family and my husbands.	He is not sick except WHEN he is sick
	We're ALL Sick....Except Jarrod	physicall, I am not sick (except A COLD)	I NEVER got sick except for maybe a brief cold each fall and spring.
	The process is exactly the SAME when I project my guilt onto my body and get sick, EXCEPT we call it sickness instead of anger.	not sick, except my PAIN WITH THE LASHES	I HARDLY get sick (EXCEPT THESE MONTHS that I'm pregnant)
	If this one comes a knockin', your body has never seen it before, it cannot defend you, and you will get SICK. EXCEPT in this case, this one is bad. ...	The affected dog is not sick, except for THE COUGH	Sick children make as big gains as the not sick except AT AGE 12 and over