Articulating Context Dependence: *Ad Hoc* Cognition in the Prototype Theory of Concepts

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ABSTRACT: Recently, Casasanto and Lupyan (2015) have asserted that there are no context-independent concepts: all concepts are constructed *ad hoc* when they are instantiated. The aim of this work is to show that a (radical) contextualist view of concepts, like that of the *ad hoc* cognition framework, may be characterized by a similarity-based prototype theory, and that two different notions of concept should be distinguished –which may be identified with two distinct facets in their life cycle (i.e., storage and instantiation)–. My approach brings together virtues from two opposing views: (a) invariantist: stored concepts are stable enough to accumulate new information about categories; (b) contextualist: instantiated concepts are context-dependent, what explain our adaptive ability to changing situations and environments.

Keywords: Concepts, contextualism, *ad hoc* cognition, prototype theory, similarity.

1. *Introduction*

Concepts play a key role in cognitive processes such as categorization, inference, learning, memory, decision making, problem solving, etc., being commonly identified with bodies of knowledge about the members of a given category. On the one hand, the traditional view, also called *invariantism* (Machery 2009), identifies concepts with cores of knowledge stable across individuals and time, which explains both the accumulation of information about categories, and our ability to communicate with other subjects. On the other hand, *contextualism* is the second main view, according to which many concepts are context-dependent construals created on the fly for each particular occasion (Barsalou 1993; Sperber and Wilson 1995; Carston 2002; Prinz 2002; Malt 2010), which explains our adaptive behavior to changing environments. For my part, I ascribe to the contextualist theses, much in line with Casasanto and Lupyan's *ad hoc* cognition framework, which is located in the scope of radical contextualism.

My aim in this work is to show that a radical contextualist view can be characterized in terms of a similarity-based approach to the prototype theory of concepts. On this basis I will try to prove that, under a contextualist view of the mind, two different notions of concept must be distinguished –which may be identified with two distinct facets in their life cycle (i.e., storage and instantiation)–. My thesis is that a (radical) contextualist perspective on concepts can exhibit virtues typically invariantist, like the ability to accumulate new knowledge about categories, which converts contextualism into a better model of how concepts work in the mind.

After setting these goals, in section 2 I introduce the *prototype theory*, as one of the main paradigms that try to explain the structure of concepts. There I distinguish two different ways in which the prototype theory can be modeled (i.e., featural models and dimensional models), and then I show that dimensional models can be articulated by means of a *similarity space theory* of concepts. Next, I explain that, in a similarity-based theory, similarities are inversely proportional to distances, what allows conceiving concepts as the cells resulting from a Voronoi partition of the conceptual space. Lastly, I argue for the need to distinguish between the prototype of a concept and its associated conceptual region, and I point out that concepts should not be identified with the conceptual regions, but with the prototypes (and the latter only in a very particular sense).

Then, in section 3 I indicate how a radical contextualist approach, like that of the *ad hoc* cognition framework, can be articulated by means of a prototype theory characterized through a similarity-based geometric space. My point there is that, inasmuch as similarities / distances are a function of variables and parameters which may depend on context (i.e., the relevant concepts, the kind of metric, or the importance of dimensions and concepts), each new instantiation of a concept in a particular context could be different. Consequently, a prototype theory of concepts –conceived in terms of a similarity space– can provide a successful characterization of (radical) contextualism.

Finally, section 4 explains why in a proposal like this (i.e., a contextualist approach characterized by means of prototypes and similarity spaces) leads to the necessity of distinguishing two distinct senses of concept, namely *concepts as storage* and *concepts as instantiation*, which could be associated with different facets in the life cycle of a concept. On the one hand, the notion of *stored concept* is that associated with the information persistently registered within our minds about a given category, and the one which guarantees the necessary continuity to accumulate new information about categories. On the other hand, *instantiated concepts* would be the result of those cognitive processes where the concept is applied (e.g., categorizations), and the ones responsible of the external manifestation of a concept.

My conclusion will be that a genuinely contextualist model of our conceptual system –like the one described in my work– can display a typically invariantist quality, as is the capability to gather new knowledge about categories, which qualifies contextualism as a better alternative for the characterization of concepts.

2. *Prototype theory and similarity spaces*

In this section I first introduce the prototype theory of concepts, and the similarity-based approaches –as a possible way of articulating the prototype theory–. Next I show how similarities can be described by means of distances (i.e., geometrical measures), what allows a characterization of similarity spaces through Voronoi diagrams. Finally, I argue that concepts should be identified with prototypes, and not with their associated conceptual regions.

2.1 *Prototype theory*

The prototype theory of concepts –also called *probabilistic view* or *family resemblance view*– is one of the main paradigms that try to explain the structure of concepts[1]. This theory purports to characterize the notion of family resemblance (Wittgenstein 1953) through the formulation of models that articulate it, and –by means of those models– to explain the typicality phenomena identified by Rosch and Mervis (1975) in many concepts, which is not possible from the standpoint of the classical theory.

On this basis, the prototype theory holds that a concept may be organized around a set of correlated attributes that shape an ideal representation –known as *prototype*–,

[1] The other main approaches are the classical theory, the exemplar theory, the theory-theory, and different pluralist/hybridist combinations of them.

which sums up the characteristic properties of the considered category. By virtue of this, it is usually said that prototypes are representations –or bodies of knowledge– whose structure encodes information about the properties that their members tend to have. Howbeit, there are distinct ways in which the prototype theory can be articulated (Smith and Medin 1981):

(a) *Featural models*: an object *o* is classified under a concept *C* if it possesses a sufficient number of the properties associated to *C*.

(b) *Dimensional models*: an object *o* is classified under a concept *C* if it *possesses to some degree* a sufficient number of those properties.

In both cases an object *o* will be categorized or not under a particular concept *C* in function of the similarity between *p* and the prototype of *C*, which will be determined by virtue of their shared properties. If, in the case of dimensional models, the objects and the prototypes of concepts are represented in a geometrical space whose dimensions are the constitutive properties of the relevant concepts for the considered context, then that would be what is known as a *similarity space theory of concepts*.

2.2 Similarity space theories of concepts

In general terms, a *similarity space theory of concepts* can be described by one fundamental thesis (Gauker 2007): the mind is a representational hyperspace within which (a) *dimensions* –or *factors*– f_i represent ways in which objects can differ, (b) *points* p_j represent objects, (c) *regions* R_K represent concepts, and (d) *distances* $d_{u,v}$ are inversely proportional to similarities –between objects or concepts–. Consequently, an object *o* will belong to a concept *C* if and only if the values of *o* in every dimension of that similarity space produce an *n*-tuple that lies inside the region associated with the concept *C*.

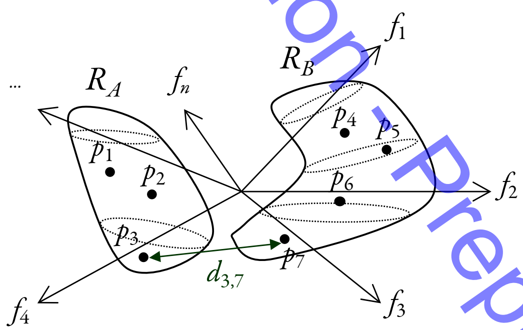

Figure 1. *Illustrative example of a conceptual similarity space.*

For instance, Figure 1 shows a conceptual similarity space constituted by *n* dimensions f_i, where the concepts *A* and *B* are represented by the regions R_A and R_B. The points p_j represent distinct objects, three of which (p_1 to p_3) are categorized under the concept *A*, while the other four (p_4 to p_7) are categorized under the concept *B*. The similarity between two objects –p_3 and p_7, for example– would be inversely proportional to the distance between them ($d_{3,7}$).

The prototypes of concepts would result from a process of maximization of similarities –or, alternatively, minimization of distances– between the evaluated objects, and the tentative prototypes. The set of final prototypes will be the one which maximizes intra-group similarity and minimizes inter-group similarity. Thence, the prototype of a concept arises as the generalization of the properties of the objects chosen as tentative members of its associated category –for instance, by means of the average of the values in each dimension of the considered objects– (Reed 1972; Nosofsky 1986). Consequently, the prototype of a concept would be the most typical member of that category, and would be represented by a point p_p which may correspond or not with a real instance of such category. Lastly, as I show below, the shape and boundaries of the conceptual regions may result from a Voronoi tessellation of the conceptual space, whose input are the prototypes of the set of relevant concepts.

Inasmuch as distances –or similarities– are a function of variables and parameters which might depend on context (e.g., the relevant concepts, the kind of metric, or the importance of dimensions and concepts), each new instantiation of a concept in a particular context may be different. By virtue of this, a prototype theory of concepts –conceived in terms of similarity spaces– can provide a successful characterization of the contextualist approach to cognition and concepts.

2.3 *Similarity measures and Voronoi diagrams*

As said above, similarity space theories define similarity as a measure that is inversely proportional to distance –i.e., between objects and/or the prototypes of concepts–, which is commonly determined according to a Minkowski metric. The formula for the distance (in a generic Minkowski metric) between two objects (and/or prototypes of concepts) *a* and *b* located within an *n*-dimensional space is the following:

$$d(a,b) = \left(\sum_{i=1}^{n} w_i \left| f_i^{[a]} - f_i^{[b]} \right|^p \right)^{1/p}$$

where $f_i^{[o]}$ represents the value of the *i*-th dimension of the object *o*; w_i represents the weight assigned to the contribution of the *i*-th dimension; and the value of the parameter *p* determines the kind of metric (e.g., if p=1 the metric is city-block or Manhattan; if p=2 the metric is Euclidean).

The expression above applies to the standard/ordinary Minkowski distance. However, those distances might be weighted differently according to various criteria. For instance, the weight could be a function of the number of examples on which a given concept is based. In such a case, the distance-of-comparison $d_C(o,P_C)$ between an object *o* and a concept *C*, may be expressed under a multiplicatively weighted scheme (Okabe *et al.* 1992, pp. 119-134):

$$d_C(o,P_C) = u_C \, d(o,P_C)$$

where u_C represents the weighting of the distances from the prototype of *C* (i.e., P_C) to any other point of the conceptual space.

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In a similarity-based space theory of concepts, the categorization of an object *o* under a particular concept is the result of a mental process that (i) evaluates the distances from *o* to the prototypes of all the relevant concepts in the considered context, and, as a result, (ii) classifies *o* under the closest concept –that is, under the concept *C* whose prototype P_C is the most similar to *o*–. On this basis, once a particular similarity measure is adopted, a similarity-based conceptual space could be characterized by means of Voronoi diagrams, inasmuch as concepts may be conceived as the cells resulting from a Voronoi tessellation of the conceptual hyperspace (see Figure 2), whose input were the prototypes of the relevant concepts.

A Voronoi diagram is a partition of an n-dimensional space into regions, based on the distances between each point and the points belonging to a particular subset G of that n-dimensional space. The points belonging to G are usually called *seeds* or *generators* and, in a prototype-based approach, those points are the *prototypes* of concepts. The general idea is that for each generator g_i there is a region constituted by those points nearest to g_i than to any other seed belonging to G. The points equidistant from their two closest generators will constitute the boundaries of regions. Thus, for example, in the case of a standard Euclidean metric where both concepts and dimensions are equally weighted (like that in Figure 2), the boundaries of regions would be determined by the bisectors of the segments connecting each pair of prototypes.

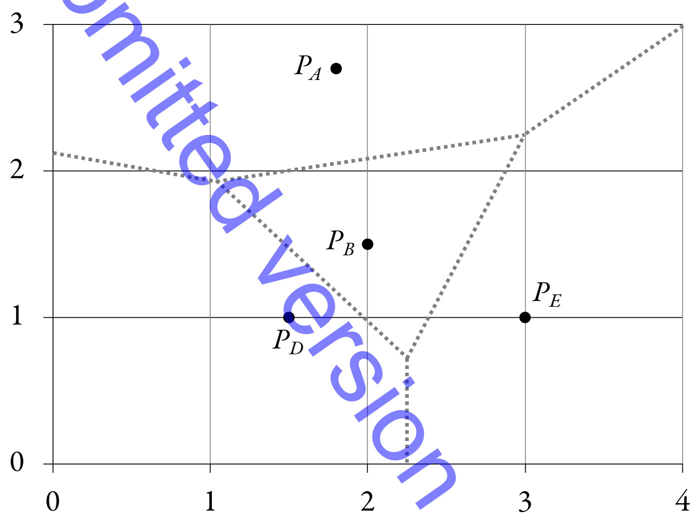

Figure 2. *Boundaries of the conceptual regions resulting from the tessellation of a Euclidean conceptual hyperspace*, by means of a maximization process following the principles of the prototype theory of concepts. The final prototypes are represented by four black dots with coordinates (1.5,1), (1.8,2.7), (2,1.5) and (3,1). The boundaries of the conceptual regions are represented by means of grey dotted lines.

2.4 On the distinction between prototypes and conceptual regions

Advocates of similarity spaces sometimes identify concepts with prototypes or conceptual regions indistinctly, as Gärdenfors does with his definition of a (natural) concept in terms of a set of conceptual regions:

> CRITERION C: A natural concept is represented as a set of regions in a number of domains together with an assignment of salience weights to the domains and information about how the regions in different domains are correlated. (Gärdenfors 2000, p. 105)

Here my point is that regions and prototypes are very different things, and that concepts must be identified with the prototypes –and not with the regions–. It is my view that there are significant reasons which support these statements:

- What results from the generalization of a set of tentative examples of a given category is a prototype, not a region. Conceptual regions only arise from the evaluation of the distances between all the points of the conceptual hyperspace, and the prototypes of the relevant concepts.
- The application of conceptual regions in categorization tasks is both unnecessary and inefficient: (A) It is *unnecessary* because in order to categorize an object only the locations of the relevant prototypes are needed. (B) It is *inefficient* –both in terms of memory and/or processing– because it compels, either to store the concept associated to every point, or to store all the boundaries and determine the region within which the considered object is situated.

Therefore, it is an error to attribute to the conceptual regions a persistent and strong ontological sense. Their function is merely explicative, because it is easier to say that «an object *o* falls within the region associated to a concept *C*», than to say that «the distance between *o* and the prototype associated to *C* is less than the distance between *o* and the prototype of any other concept distinct to *C* (and relevant for that context)».

In consequence, the *information stored* by our cognitive system about concepts are the locations of their prototypes, and not their associated regions and/or boundaries.

3. *A prototype-based approach to radical contextualism*

My aim in this section is to show that a radical contextualist perspective –like that of Casasanto and Lupyan's *ad hoc* cognition framework–, according to which concepts always depend on context, can be characterized by means of a similarity-based approach to the prototype theory of concepts, and how such a characterization could take place.

3.1 *The ad hoc cognition framework*

Casasanto and Lupyan (2015) have proposed an appealing thesis: *there are no context-independent concepts* –that is, *all concepts are ad hoc concepts*[2]–. They also argue that the seeming stability of concepts is merely due to commonalities across their different instantiations but that, in fact, there is nothing invariant in them. On their view, which is based on Wittgenstein's discussion of *family resemblances* for the term "game" (according to which there is nothing in common to all the activities we call "games" (Wittgenstein 1953, §66-100)), the phenomenon identified by Wittgenstein is completely general, that is, it extends to every possible concept. And, if the *core*[3] of a concept is conceived as those properties common to every object categorized under that concept (i.e., properties which are essential to that category, independently of the considered context), then it cannot be drawn a boundary between a concept's core and its "periphery", by virtue of the impossibility of identifying the core of no concept. Furthermore, Casasanto and Lupyan convincingly argue that it is necessary to abandon the idea that concepts have stable –or default– cores accessed by people when they instantiate those concepts. Or, in other words, that there is nothing invariant in concepts, so there is no set of stable and context-independent properties accessed whenever subjects instantiate a concept.

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[2] Casasanto and Lupyan's position is clearly inspired by Barsalou (1987).

[3] According to the distinction between a concept's *core* and its *identification procedure* (Armstrong *et al.* 1983).

In agreement with this, every instantiation of a concept would be produced on the fly from a set of contextual cues in an occasion specific manner. In particular, Casasanto and Lupyan (2015, pp. 553-557) distinguish three types of overlapping contextual information depending of the considered time scale: (I) *Brain activation dynamics*: the subject's cognitive state is always changing, as a result of its own brain activity, which entails a continuous reconfiguration of the cognitive system in function of its acts of perception and conception (i.e., in terms of the currently perceived inputs and instantiated concepts). (II) *Local context*: subjects instantiate concepts based on the cues received from their local contexts (i.e., physical, social, biological and neuro-cognitive), which has influence over the mental representations produced by those subjects. (III) *Experiential relativity*: persons are exposed to different linguistic, cultural or bodily experiences, and that may explain their distinct conceptualizations of time, space, movement, color, morality, etc.

Based on this, Casasanto and Lupyan maintain that, given that the subject's cognitive state is a part of the context, and considering that the brain is continuously changing, this implies that concepts are inherently variable. Hence, if Casasanto and Lupyan are right, concepts would only exist when they are instantiated (i.e., when they are applied by a subject in categorizations, inferences, etc.), and it is for that reason that they sum up their view as follows:

> Concepts are not something we *have in* the mind, they are something we *do with* the mind. (Casasanto and Lupyan 2015, p. 546)

For my part, I sympathize with the view that where we "see" concepts, what there is in fact is the result of cognitive processes (i.e., categorization, comprehension, inference, etc.) Nonetheless, after asserting that *concepts are not something we have in the mind, but something we do with the mind*, Casasanto and Lupyan focus their work on the instantiation of concepts, leaving aside the issue of which cognitive structures might ground those instantiations. Indeed, what they say regarding the information required to instantiate a concept is too vague to be an explanation of how that process happens:

> We will use the term *concept* to mean a dynamic pattern of information that is made active in memory transiently, as needed, in response to internally generated or external cues. (...)
>
> Rather than a process of accessing a preformed package of knowledge, instantiating a concept is always a process of activating an *ad hoc* network of stored information in response to cues in context. (Casasanto y Lupyan *ib.*)

Therefore, in order to accept the theses of the *ad hoc* cognition framework, a characterization of the cognitive structures supporting the instantiation of concepts is demanded. The following subsection is devoted to the issue of how a radical contextualist approach, like that of Casasanto and Lupyan's, might be articulated by a theory on the structure of concepts –and, more particularly, by the prototype theory–, paying special attention to the question of how the context-dependence of instantiated concepts may be put in place by means of a geometric similarity space.

3.2 A model for ad hoc cognition

Now let us see how a (radical) contextualist framework –like the *ad hoc* cognition– may be articulated by means of a similarity space theory of concepts. As said above, in this kind of theories similarity is a measure inversely proportional to the distances between objects and/or the prototypes of concepts. On this basis, an object *o* is categorized under a concept G if the distance-of-comparison between o and G (that is, $d_G(o,P_G)$) is less than the distance-of-comparison between o and any other relevant concept in that context. Or, in other words, if **C** is the set of relevant concepts in the considered context, then when $\forall C \in \mathbf{C}$ it is true that $d_G(o,P_G) < d_C(o,P_C)$, the object o will be categorized under the concept G. It is in this kind of cognitive process where the *instantiation* of a concept occurs, which consists in the evaluation of the similarities of a particular object –or concept– with regard to the set **C** of relevant concepts in that context.

Inasmuch as distances –and similarities– are a function of the parameters p, w_i and u_C (see section 2.3), and given that the categorization of an object depends on which the relevant concepts are, thence there are at least four context-dependent factors that can affect the instantiation of every concept in this characterization of the *ad hoc* cognition framework:

— the instantiated concepts –set **C** of relevant concepts–,
— the kind of metric –parameter p–,
— the importance of dimensions –weights w_i–, and
— the significance of concepts –weights u_C–.

Relevant concepts

First, a categorization process will produce different partitions of the conceptual space depending on the set **C** of concepts relevant in the considered context (i.e., depending on the locations of the pertinent concepts), which will lead, consequently, to distinct instantiations of those concepts.

Consider the following example. Let be a subject S whose default conceptual space for the case of a categorization process of citruses is that shown in Figure 3a, where the horizontal axis might be identified with the *color* dimension and the vertical axis may be identified with a mixture of *texture* and *shape*.

However, if the subject S were in a context where he did not expect that the fruit that grows in a tree could be a lime (perhaps because S is in a place where he knows that there are not lime trees, or because its presence there is quite rare), then LIME might not be a relevant concept in that categorization process. In that case, any object previously categorized as a lime would be now classified under the concept LEMON (see Figure 3b). A similar phenomenon may happen if GRAPEFRUIT did not belong to the set **C** of relevant concepts, and instead TANGERINE was an element of **C** (see Figure 3c); or if the subject S thought he was facing fake lemons (e.g., plastic, wooden or painted lemons) (see Figure 3d).

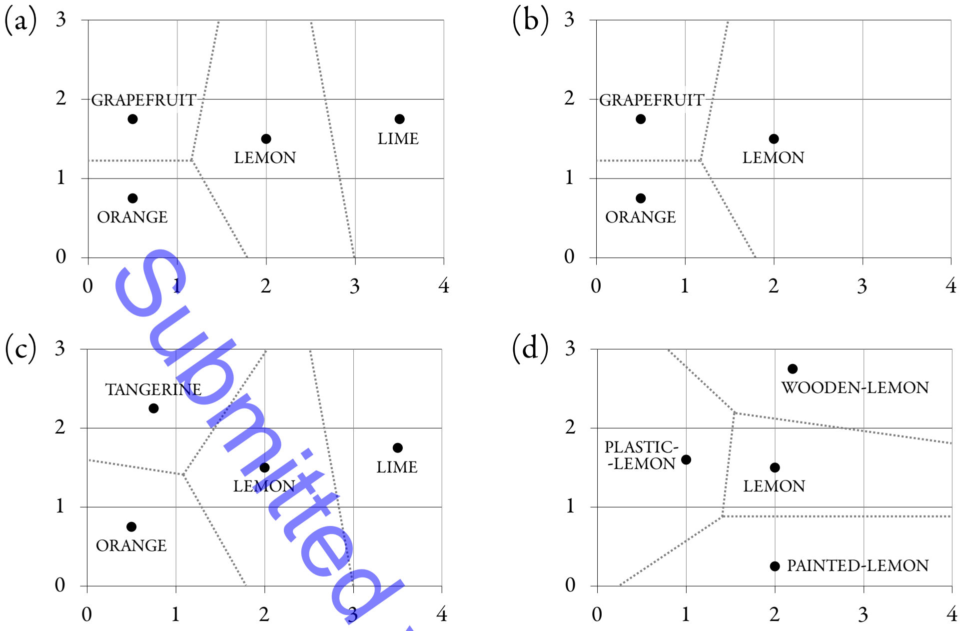

Figure 3. *Example of contextual dependence of concepts due to the set of relevant concepts*, for a categorization process of citruses where abscissas may be identified with *color*, and ordinates with a mixture of *texture* and *shape*. (a) Default context with prototypes of the concepts LEMON, ORANGE, GRAPEFRUIT and LIME located in the coordinates (2,1.5), (0.5,0.75), (0.5,1.75) and (3.5,1.75), respectively. (b) Context where the concept LIME is not relevant. (c) Context where the third relevant concept were not GRAPEFRUIT, but the concept TANGERINE, located in (0.75,2.25). (d) Context where the relevant concepts were LEMON, PAINTED-LEMON, PLASTIC-LEMON and WOODEN-LEMON, the last three located in (2,0.25), (1,1.6) and (2.2,2.75), respectively.

Kind of metric

Nonetheless, it might happen that there exist two distinct contexts $\mathcal{H}$ and $\mathcal{I}$ such that their sets of relevant concepts were the same (i.e., such that $\mathbf{C}_{\mathcal{H}}=\mathbf{C}_{\mathcal{I}}$, where $\mathbf{C}_{\mathcal{X}}$ represents the set of concepts relevant in the context $\mathcal{X}$), but whose metrics were not identical. In that case, different metrics will produce, even for the same set of prototypes, distinct partitions of the conceptual space and, consequently, different instantiations of those concepts.

Now, consider again the instantiation represented by Figure 3a, whose metric was Euclidean –instantiation reproduced in Figure 4a–. This could be the case of a context where the subject is so used to classifying citruses according to the dimensions of *color* and *texture-shape* that his perceptual and cognitive system jointly processed both dimensions.

By contrast, if the context were such that the dimensions of *color* and *texture-shape* were separately processed (perhaps because the subject is encouraged to attend to the individual differences in those two dimensions; or at some previous time when that subject was not used to doing that task), then the applied metric might be the city-block (i.e., parameter p=1) (see Figure 4b). Indeed, there is empirical evidence that the selective attention to the considered dimensions may change how similarity relations are determined, so dimensions commonly integral (with parameter p=2) can be evaluated separately (parameter p=1), and vice versa (Goldstone and Steyvers 2001).

Obviously, instantiations would be different for other kinds of metric (see Figure 4c and Figure 4d for metrics with parameter *p*=3 and *p*=1.7, respectively).

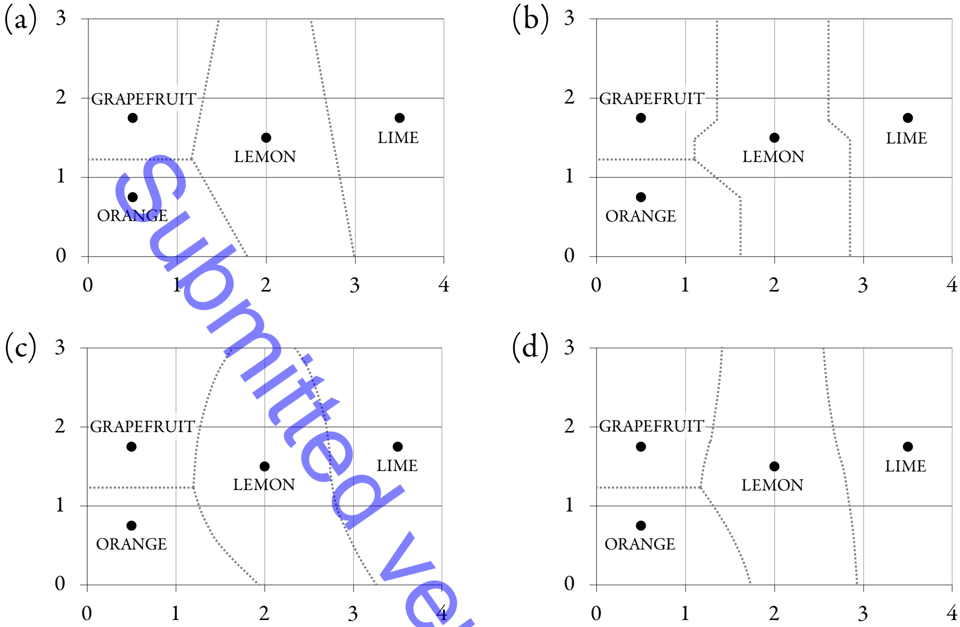

Figure 4. *Example of contextual dependence of concepts due to the kind of metric*, for a categorization process of citruses with the same set of relevant concepts as the one represented in Figure 3a, located in the coordinates (2,1.5), (0.5,0.75), (0.5,1.75) and (3.5,1.75), respectively. (a) Context with Euclidean metric (*p*=2). (b) Context with city-block/Manhattan metric (*p*=1). (c) Context with higher-order metric (*p*=3). (d) Context with optimal metric for integral dimensions (*p*=1.7) (Handel and Imai 1972).

Importance of dimensions

However, even though two different contexts shared the same set of relevant concepts and also the same kind of metric, if the importance received by the dimensions constitutive of the underlying conceptual hyperspace were distinct –in the limit, some weights could be equal to zero–, that would produce different instantiations of those concepts.

Look again at the instantiation shown in Figure 3a, whose metric was Euclidean and where all dimensions are equally weighted (which is reproduced in Figure 5a).

Consider now the case of a context where the subject watches the scene from a certain distance, by virtue of which his perception of the texture and shape of objects is not too accurate. In that case, the subject's cognitive system might overweight the dimension of *color*, for instance, assigning to it twice the weight of the mixture of *texture* and *shape*, which would produce a different instantiation of the considered concepts (see Figure 5b). Alternatively, it could happen that –in another context– the *color* dimension had little importance (for instance, if the subject is in a dark environment, where the hue of color cannot be clearly distinguished; or if he was in a context of unripe fruits, where all of them were –more or less– greenish). In such a case, the mixture of *texture* and *shape* might have twice or thrice the importance of the *color* dimension, resulting in other two different instantiations of those concepts (see Figure 5c and Figure 5d, respectively).

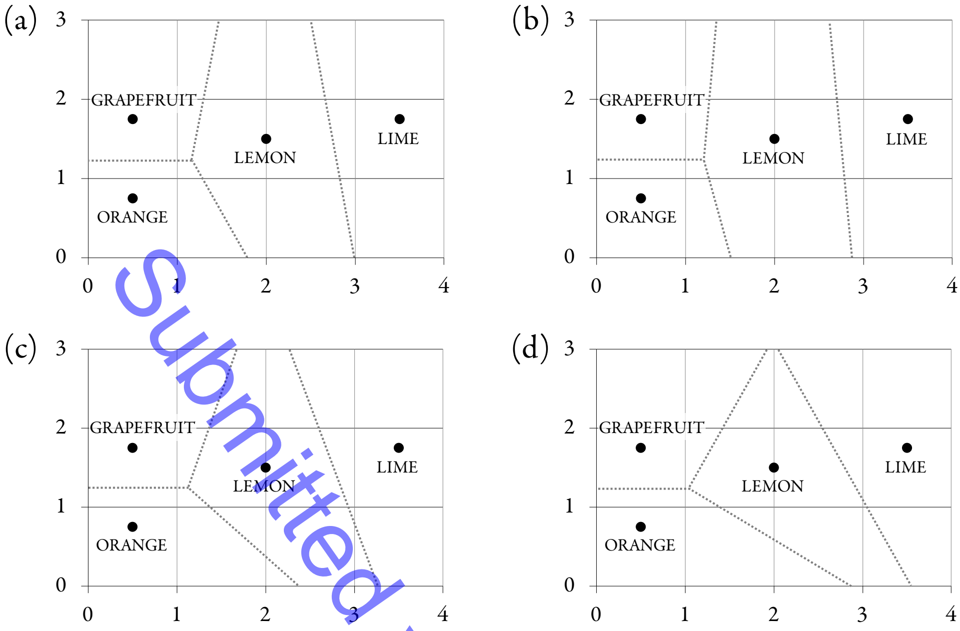

Figure 5. *Example of contextual dependence of concepts due to the importance of dimensions*, for a categorization process of citruses with Euclidean metric based on the *color*, horizontal axis, and a mixture of *texture* and *shape*, vertical axis. (a) Default context with equally weighted dimensions [weights (1,1)]. (b) Context where *color* had twice the importance of the mixture of *texture* and *shape* [weights (2,1)]. (c) Context where the mixture of *texture* and *shape* had twice the weight of *color* [weights (1,2)]. (d) Context where the mixture of *texture* and *shape* had thrice the importance of *color* [weights (1,3)].

Significance of concepts

Lastly, it could happen that although all the previous factors were the same in two particular contexts, the significance of concepts were not equal in both situations. In such a case, the distances-of-comparison (that are used in categorizations) would be differently weighted in each context, and that would produce distinct instantiations of the relevant concepts.

Let's consider again the conceptual space represented by Figure 3a –where the four instantiated concepts (i.e., LEMON, ORANGE, GRAPEFRUIT and LIME) were equally weighted–, which is reproduced in Figure 6a.

But, context could be such that concepts were distinctly weighted according to: (i) the relative frequencies of the examples observed in the subject's life course; and/or (ii) the subject's interests and/or expectations in the considered context. For instance, in the case of a weighting based on frequencies, if weights were (1.1,1.2,1,1)[4] (that is, if orange is the most frequent citrus, and lemon is the second one, equally followed by grapefruit and lime), the instantiated concepts would be those shown in Figure 6b. By contrast, if the subject S works in a production line of lime nets where most of the citruses are limes,

[4] These weights –and all the other weights that will appear in this subsection– are relative to similarities, that is, they are the inverse of the weights u_C (associated to distances) that appeared in the multiplicatively weighted scheme shown in section 2.3.

even though sometimes unripe lemons also appear, the subject *S* might be especially sensitive to limes, and slightly less sensitive to lemons –so that the weights of concepts were (1.3,1,1,1.5)– (see Figure 6c). Finally, a fourth possible context might be one in which oranges and lemons were equally –and significantly– overweighed regarding grapefruits and limes, which would happen for the quadruple of weights (2.5,2.5,1,1) (see Figure 6d). That would be the case if the subject –a child, for example– had been exposed to a very small number of grapefruits and limes; or, in other words, if the majority of citruses seen by the subject had been oranges and lemons.

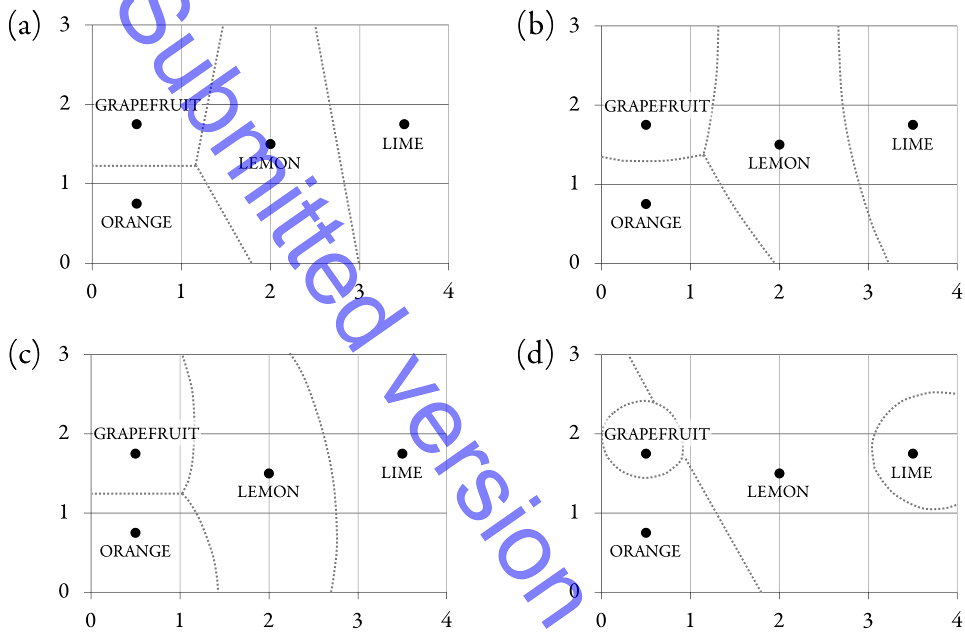

Figure 6. *Example of contextual dependence of concepts due to the significance of the relevant concepts*, for a categorization process of citruses with the same set of relevant concepts as that represented in Figure 3a. (a) Default context with equally weighted concepts [weights (1,1,1,1)] (associated to LEMON, ORANGE, GRAPEFRUIT and LIME, respectively). (b) Context with concepts weighted by their relative frequency [weights (1.1,1.2,1,1)]. (c) Context for a worker in a production line of lime nets [weights (1.3,1,1,1.5)]. (d) Context for a child who had been exposed to a small number of grapefruits and limes [weights (2.5,2.5,1,1)].

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Thence, each new instantiation of a concept in a particular context will be different, given that the relevant concepts, the kind of metric and the importance of dimensions and concepts will vary from context to context.

In consequence, a prototype theory of concepts (conceived in terms of a geometrical similarity space) can provide a successful account of the contextualist thesis that *all concepts are ad hoc concepts* –or, in other words, of the thesis that the instantiation of every concept depends on the context on which such an instantiation happens–.

4. *Two-faceted concepts*

Hitherto, two different notions of concept have been tacitly used in the previous sections. Now I claim that it is worthwhile distinguishing those two senses of concept –which should not be confused–, and that they can be identified with distinct facets in the life cycle of a concept.

On these bases I will hold that a genuinely (radical) contextualist view of the mind, like one described in this work, can exhibit virtues typically invariantist, like the ability to accumulate new information about categories.

4.1 *Concepts as storage*

The first notion of concept is that associated with the information stored within our cognitive system about a certain category. From here on I will refer them as *stored concepts* –or *concepts as storage*–.

In the case of my proposal, that is, a prototype theory of concepts built over a geometric similarity space, the only information which needs to be registered by our cognitive system is the location of the prototype associated to each concept. Such locations are the only thing required to instantiate a concept within a particular context –that is to say, to determine the distances and similarities between that concept and any other object or concept–. Therefore, *stored concepts* would be the information persistently registered by our minds about the location of their prototypes.

However, although the stored concept is the starting point for any instantiation of a concept –which may take place in cognitive processes such as categorization–, the stored concept cannot determine the output of those processes by itself, because additional contextual factors are involved in them. (Remember that the instantiation of a concept requires the calculation of distances / similarities between the evaluated object and the prototypes of all the context-relevant concepts, and that such computation depends on the kind of metric, the importance of dimensions, and the significance of the relevant concepts.)

Finally, *stored concepts* provide the continuity needed to accumulate new information over time about categories (e.g., when as a result of subsequent executions of the learning processes new properties are added to the previously stored locations of their prototypes). The advantage of this view is that, from a radical contextualist approach, it is possible to explain a typically invariantist ability –to wit, the accumulation of new knowledge by individuals–, which places contextualism in a better position to provide a complete model of how concepts work in the mind.

4.2 *Concepts as instantiation*

As said above, the mere information stored about a concept does not explain how that concept is used in tasks such as categorizations, inferences, etc. The reason is that what is involved in those cognitive processes is not the stored concept, but the *instantiated concept* –or *concept as instantiation*–, which results from the application of part of that information in a context-dependent way. These instantiated concepts can be identified with the *ad hoc* concepts proposed by Casasanto and Lupyan, that is, they might play the role attributed to concepts by a radical contextualist approach.

However, the idea of *instantiated concept* is more slippery than the notion of *stored concept*. This is so because stored concepts can be thought to be persistently backed by a certain structure, either informational –record system, neural network, etc.– or physical

–potential level, electrochemical gradient, etc.–, but an identification like this is not possible for the instantiated concepts.

The reason why is that the instantiated concept is produced on the fly depending on the subject's context, every time such a concept is considered relevant for a categorization process. Therefore, *concepts as instantiations* exist only as a result of cognitive processes associated to categorizations, inferences, etc., in spite of which they are responsible of the external manifestation of those concepts. (In fact, the result of those processes is the only sort of empirical evidence that we have about what we call "concepts".) Hence, the instantiated concepts are not something that exists; conversely, they are something that happens at the end of that kind of cognitive processes.

4.3 Two facets in the life cycle of a concept

Finally, my view is that *storage* and *instantiation* are not distinct notions of concept resulting from alternative theories about what concepts are, but different facets in the life cycle of a concept. In the first place, when a concept *C* is acquired our cognitive system stores certain information about it. Under the assumption of a similarity space theory of concepts, that information (or *stored concept*) would be the location of the prototype associated to *C*, which is registered in a stable and persistent way until new perceptual information triggers a revision of that concept. At a later time, when *C* is used as a tentative concept for the categorization of an object under a particular concept, part of the information stored about *C* is read from memory, together with both information stored about other concepts relevant in that particular context, and other context-dependent factors. This latter cognitive process gives rise to the *instantiated concepts*, which are absolutely dependent on the actual context and that, due to it, cannot exist before all the contextual factors are determined from that context –that is to say, instantiated concepts only exist at the end of the processes of categorization, inference, etc., which instantiate them–.

Obviously, this sort of life cycle of a concept is not linear but circular, because: (i) part of the information stored about concepts is used in order to instantiate them, thus the instantiated concepts depend on the stored concepts; and (ii) the categorizations of objects resulting from different instantiations of a concept will be used by subsequent executions of the acquisition processes, which will lead to the modification of the previous version of the stored concept associated to that category.

5. Conclusions

In this work I have tried to show that a (radical) contextualist approach –like that of the *ad hoc* cognition framework– can be characterized by means of a prototype theory of concepts developed in terms of a geometrical similarity space. My proposal was compatible with the contextualist thesis that there are no context-independent concepts, and –in the pages above– I have identified four distinct possible sources of contextual dependence: relevant concepts, kind of metric, importance of dimensions, and weights of concepts.

Additionally, two different notions of concept have been distinguished, which are associated with distinct facets in their life cycle: (a) *concepts as storage*, or information persistently registered by the mind about concepts, and stable between different executions of the concept-acquisition processes; and (b) *concepts as instantiations*, or the ones responsible of the external manifestation of concepts –in mental processes such as categorizations and inferences–, which only exist when they are applied in those cognitive processes.

The major advantage of my proposal is that it brings together virtues, both from the contextualist and the invariantist approaches. Firstly, it articulates a contextualist framework compatible with the evidence against the existence of definitions (or conceptual cores) and, consequently, able to provide an account of our adaptive abilities to changing environments. Secondly, stored concepts are stable enough to explain how new information on them is gathered. Lastly, in spite of the latter invariantist virtue, the approach in my work is genuinely contextualist –and not a middle ground between invariantism and contextualism–, since real concepts are identified with those which intervene in categorizations, inferences, etc. (i.e., with instantiated concepts specifically produced for each particular context).

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