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# Superordinate and domain category structure: Evidence from typicality ratings

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RESUMO

A tipicidade dos conceitos demonstra a natureza gradativa da pertença a categorias. No entanto, ao nível mais geral do domínio semântico, a tipicidade tem sido pouco estudada. O domínio semântico é fundamental em muitas abordagens teóricas sobre a implementação neurológica de categorias semânticas, com estudos a debaterem qual a classificação de domínio mais adequada: ser vivo/não vivo vs. animado/inanimado. Nesta investigação, recolheram-se julgamentos de tipicidade para melhor entender: (1) a relação entre os níveis categoriais de domínio e sobreordenado e (2) a organização interna dos domínios semânticos. Dez categorias sobreordenadas de 280 itens foram estudadas. A categorização ao nível do domínio distinguiu-se da categorização sobreordenada em várias dimensões, nomeadamente com a tipicidade a relacionar-se, não com a *partilha de atributos*, mas sim com a prevalência de *tipos de atributos*. A distinção animado/inanimado foi apoiada por uma análise mais simples de tipos de atributos e por uma categorização sobreordenada mais consistente. Propõe-se que a categorização ao nível do domínio semântico se baseia em processos que são largamente independentes dos processos de categorização mais específicos, a nível sobreordenado, e que ocorre ao longo da dimensão animado/inanimado.

Palavras-chave: tipicidade; atributos; sobreordenado; domínio; memória semântica

ABSTRACT

Concept typicality demonstrates the graded nature of category membership. At the most general (domain) level, however, typicality has not been studied. The domain level plays a critical role in theoretical accounts of the neurological implementation of semantic categories, with studies being divided along the correct domain classification: living/nonliving vs. animate/inanimate. We collected typicality ratings to further understand: (1) the relation between categorization at the domain and superordinate levels and (2) the internal organization of the domain level. Ten superordinate categories across 280 items were studied. The domain level was distinguished from the superordinate level along multiple dimensions, including typicality being unrelated to *feature sharedness*, but related to prevalence of *feature types*. The animate/inanimate distinction was supported by a simpler feature type analysis and a more reliable superordinate categorization. We argue that domain categorization relies on processes that are largely independent from those at the more specific, superordinate, level and occurs along the animacy dimension.

Keywords: typicality; features; superordinate; domain; semantic memory

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J. Frederico Marques was involved in all parts of this study, including conceptualizing the study, planning the methods, analyzing the data, and writing the first version of the manuscript. Unfortunately, he passed away before the manuscript was accepted for publication. We thank him for his guidance and scholarship.

## INTRODUCTION

Over the last century, artists have challenged conventional definitions or representations of categories. They have made chairs from a single piece of material, from unconventional materials (e.g., glass or paper), and into structures that did not include a flat bottom or a back. Philosophical and psychological work during this time had the opposite agenda: finding the necessary and sufficient criteria for category membership (Mervis & Rosch, 1981; Murphy, 2004; Smyth, Collins, Morris, & Levy, 1994). However, for many categories it proved impossible to derive criteria that were inclusive of all members and exclusive of all nonmembers (Wittgenstein, 1953). Only *characteristic* features could be identified; features often associated with category members, but never with all members (Smith, Shoben, & Rips, 1974). Moreover, empirically, the data demonstrated inconsistent categorization of some members (McCloskey & Glucksberg, 1978), graded judgments of category membership, and faster and more accurate categorization, the better the exemplars, spanning physical (e.g., colour) to conceptual (e.g., semantic categories) domains (Rosch, 1975a, 1975b, 1975c). These results led to the general acceptance that category membership was graded rather than all-or-none, where some members were more representative or *typical* of a category than others (e.g., robin vs. penguin for bird).

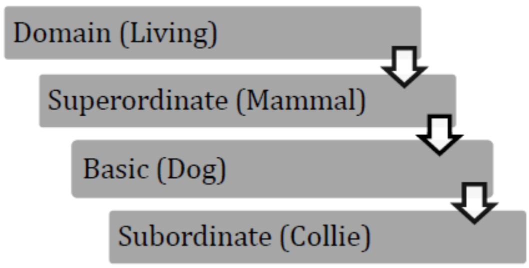


*Figure 1*. Hierarchical ordering of categories. Ordering proceeds from most general at the top (i.e., domain) to most specific at the bottom (i.e., subordinate).

The empirical study of category typicality has been constrained to more specific levels (i.e., superordinate) of the hierarchical ordering of categories (McCloskey & Glucksberg, 1978; Rosch, 1975a, 1975b, 1975c). This hierarchical ordering proceeds from specific to general across four levels: subordinate, basic, superordinate, and domain. The most specific level is subordinate (e.g., collie), followed by basic (e.g., dog), then superordinate (e.g., mammal) and finally the most general level, domain (e.g., living; see Figure 1). In categorizing everyday objects, we tend to use the basic level and occasionally the subordinate level (Lin, Murphy, & Shoben, 1997; Rosch, Simpson, & Miller, 1976), depending on one's particular expertise (Coley, Medin, & Atran, 1997; Johnson & Mervis, 1997). The Category Differentiation Account attributes this level's privileged status to maximizing the balance between *informativeness* (i.e., the amount of information a category provides) and *distinctiveness* (i.e., related to distinctive features that occur in only one or very few concepts and thus allow people to discriminate among similar concepts). While maximizing informativeness with distinctiveness is to some degree contextually determined (e.g., depending on whether the person is an expert or novice), most often it applies to the basic level.

Perhaps for this reason most research on typicality has focused on superordinate categories, the category level that structures basic level concepts. The following sections will review our understanding of typicality at the superordinate level and then on the basis of neuropsychological and developmental data demonstrate the equally, though distinct, “special” status of the domain level. This motivates the investigation of typicality at this level, as the reward of such an endeavour will be in shedding light on the potentially distinct forms of category representations and processes across these hierarchical levels, where each have privileged but distinct roles. Study 1 will investigate the role of feature sharedness and feature type in relation to typicality at both superordinate and domain levels to identify similarities/differences in the underlying representations of these two levels. The alternative domain divisions (specifically living/nonliving, animate/inanimate, or both) that have featured in the literature with varying support will be discussed along with an argument for how typicality may be able to adjudicate between them. Specifically, both domain divisions will be assessed for the consistency of typicality ratings within a domain category and distinction between domain categories (Study 1 and 2). The rationale is that consistency in typicality ratings indicates a common grouping, whereas a distinction is indicative of a border.

The typicality of an item has been explained by both how much the item shares features with other members of the category and by how little it shares features with members of contrast categories. This double dependency has been referred to as *family resemblance* (Rosch & Mervis, 1975). Although the relationship between typicality and feature sharedness intra-categorically (i.e., between a given concept and all other concepts of the same category) has been clearly demonstrated (Hampton, 1979; Rosch & Mervis, 1975; Verbeemen, Vanoverberghe, Storms, & Ruts, 2001), the relationship between typicality and feature sharedness inter-categorically (i.e., between the same concept and concepts of contrast categories) rests on more indirect data (Rosch & Mervis, 1975) or is restricted to the case of more interrelated concepts (Ameel & Storms, 2006). This relationship between feature sharing within a category and typicality will be referred to as *feature sharedness*[1]. This relationship has been demonstrated for both natural and artificial categories at superordinate and basic levels (Rosch & Mervis, 1975; Rosch et al., 1976).

The claim that typical exemplars share more features with other members than atypical exemplars is supported by so-called *typicality effects*. Typicality effects demonstrate that item typicality significantly predicts response times in category verification tasks, with faster responses observed for more typical items (e.g., deciding if a robin is a bird) than less typical items (e.g., deciding if a penguin is a bird; Casey, 1992; Hampton, 1979; Kiran, Ntourou, & Eubank, 2007; Larochelle & Pineau, 1994; Rosch, 1975b). Task completion has been assumed to require a comparison of features across members of the category, with the particular instantiation of the comparison varying across theoretical frameworks (e.g., Dry & Storms, 2010; Rosch & Mervis, 1975; Smith, et al., 1974). Not only does typicality predict response times in category verification tasks, but also in naming tasks (Holmes & Ellis, 2006).

[1] Some of the authors have used this term previously to describe the degree that an individual feature is shared by other concepts of a category (Raposo, Mendes, & Marques, 2012). Here, we are assessing the degree that all features of a concept are shared by other concepts of a category. Given that fundamentally, both involve a similar operation (either over one or multiple features) we have decided to use this term at both levels.

The relation of typicality to naming directed the question to whether typicality simply reflects familiarity or frequency, as both correlate with naming ease. Various pieces of evidence stand in contrast to this position. Studies have demonstrated that familiarity has a special relation with typicality as typical items are generally familiar, but atypical items can be more or less familiar (Glass & Meany, 1978). In the case of word frequency, there are conflicting results, with one study demonstrating a relationship with typicality (Holmes & Ellis, 2006) and another failing to do so (Mervis, Catlin, & Rosch, 1976). Importantly, however, a large number of studies have demonstrated that typicality has predictive power above and beyond frequency and familiarity (Barsalou, 1985; Marques & Morais, 2000; McCloskey, 1980; Woollams, Cooper-Pye, Hodges, & Patterson, 2008). Most critical for our interests is Rosch et al.'s (1976) demonstration that typicality predicted family resemblance of artificial categories even when object frequency was controlled. Similar results were provided by Barsalou (1985) for natural categories when predicting central tendency (a measure related to family resemblance) from typicality, while controlling familiarity. Collectively, the results indicate that typicality is to some degree independent from either frequency or familiarity. Based on this data, it seems likely that these two variables would also make a minor contribution to feature sharedness of *natural* categories, but it remains an empirical question, as this particular relationship has not been assessed (Dry & Storms, 2010; Hampton, 1979; Rosch & Mervis, 1975).

Interestingly, typicality studies have focused on categories at the superordinate or basic level and to our knowledge no work has been conducted at the domain level. Possibly, domains have been overlooked because they are not categories that people actually use but theoretical divisions. While they are certainly more abstract in nature, there is evidence indicating that the domain division is used in organizing the world and our knowledge. Linguistically we can find various examples of the domain distinction. In English, we see this in the case of question pronouns (*who* for animates vs. *what* for inanimates) as well as personal pronouns (i.e., he/she vs. it). Further other languages make animacy distinctions in noun classes or word order preferences (e.g., Ojibwe, and Navajo)[2]. Linguistically, it seems that we do use the domain category distinction quite regularly in carving up the world, even if we do not use the category label explicitly, as we do for more specific categories. As the superordinate level is used less than the basic level, it is not then surprising that the even more general, domain level, should be used even less often, at least explicitly. Developmental and neuropsychological research also suggests that the domain level is a fundamental categorical distinction. Children distinguish animate from inanimate concepts early on (Rakison & Poulin-Dubois, 2001). Neuropsychological data demonstrates that damage to a particular cerebral region (usually along inferior temporal cortex) can result in selective deficits to either the living or the nonliving domain (Capitani, Laiacona, Mahon, & Caramazza, 2003; Caramazza & Shelton, 1998; Warrington & McCarthy, 1987; Warrington & Shallice, 1984). Furthermore, degenerative diseases, such as Alzheimer's Disease (AD), and cases of herpes simplex encephalitis, have also demonstrated such domain-specific deficits (Zannino, Perri, Carlesimo, Pasqualetti, & Caltagirone, 2002). Importantly, these distinctions remain even when controlling for various variables that are not readily equated across domains, such as familiarity, visual complexity, and lexical frequency (Caramazza & Shelton, 1998).

[2] Grammatical animacy tracks conceptual animacy quite strongly, but certainly not perfectly.

Although referred to as category- or domain-specific, it is important to bear in mind that these deficits are proportional and not all-or-none. That is, there are significantly higher errors in one category over the other, and even in the “spared” category the patients fail to demonstrate knowledge about specific items. As such, it is possible that patient performance may be related to typicality at domain level. Presumably, superordinate categories and their respective category members are organized into these domains because they share features (at one level of abstraction or another) that characterize the exemplars as living or non-living in nature (Dry & Storms, 2010).

### ***Current study***

Typicality has not been studied for these more general categories (i.e., domain) and, hence, it is unclear whether domain typicality is related to feature sharedness or to other relevant feature measures. Feature type (e.g., sensorial, functional, encyclopaedic, etc.) seems a promising candidate, as it has played a particularly critical theoretical role in the distinction between domains in explaining category-specific deficits (e.g., Cree & McRae, 2003; Marques, 2002, 2005).

#### *Domain typicality as related to features (Goal 1)*

One of the first and more prominent accounts of category-specific deficits proposes that impairments in the living domain relate to deficits in representing perceptual features that are critical for the representation of living objects, while deficits to the nonliving domain were due to the inability to represent functional features (Warrington & Shallice, 1984). This theory has since been elaborated to consider a more complex combination of feature types in contributing to domain representations. Most theoretical positions implicate, at least in part, the prevalence of particular feature *types*, but not specific features, in representing the domain level. This focus on feature types rather than specific features also nicely maps onto the more abstract nature of domain categories, both in terms of their representation and linguistic reference. Given this, it is expected that typicality at this level does not correlate with sharing of specific features but a higher level of abstraction: the type of feature. This will be tested in Study 1.

#### *Animate/Inanimate or Living/Nonliving as Fundamental Domain Distinction (Goal 2)*

Subsequent to initial neuropsychological studies identifying the domain distinction as being between living and nonliving objects, further investigations of patients revealed dissociations within the living domain. Animals can be impaired independently of fruits, vegetables, and plants (Hillis & Caramazza, 1991). This challenged the initial living-nonliving division, resulting in some authors proposing a tripartite division of animals, plants, and artefacts (Cree & McRae, 2003) or an alternative division: animate vs. inanimate (Caramazza & Shelton, 1998).

The animate/inanimate division is consistent with the data observed first in children. Children discriminate animate from inanimate objects early on, but have more difficulty with the living domain classification. For instance, children have difficulty grouping animals and plants together and make errors in attributing plants to the "alive" category (Wellman & Gelman, 1998).

Along with these developmental findings, recent results from neuroimaging of both healthy human and monkey subjects support the animate/inanimate distinction (rather than the living/nonliving division). In particular, in both the human and monkey brain there are response-sensitive areas of inferior temporal cortex that categorize according to animate and inanimate items (Kriedgeskorte et al., 2008). The distinction between the two domain categorizations primarily rests upon categories such as fruit and vegetables, which categorize differently across the two domain distinctions. In the animate/inanimate distinction they classify with inanimates (along with tools), whereas in the living/nonliving distinction they classify with living items (such as animals and birds). Kriedgeskorte et al. (2008) presented pictures of various concepts to the subjects (e.g., snake, banana) and had them perform a colour discrimination task. The subject had to indicate whether the fixation-cross changed from white, to blue or green. They found that fruits and vegetables were represented in the same section of cortex along the inferior temporal lobe where most other inanimate, but not animate, objects were localized, thus supporting the animate/inanimate distinction. Importantly however, given the nature of the task, it is not clear to what extent the items were processed beyond their visual features (i.e., function and otherwise).

A more holistic measure of all feature types that collectively contribute to category membership can be gained from typicality ratings, as typicality of category membership considers the entire distribution of features. Thus, it is of interest to determine whether typicality judgments in healthy adults favour an animate vs. inanimate classification over a living vs. nonliving one, or whether it emphasizes the importance of both, depending on the particular category. This question is informative to the organization of the semantic system. Studies 1 and 2 determine under which of these two systems (living/nonliving, animate/inanimate) typicality distributes better and decisively.

To recapitulate, the first goal of the current study was to extend the study of typicality to the domain level and to evaluate the role of feature sharedness and feature type in determining typicality at domain and superordinate levels. Specifically, the domain typicality data will be used to identify whether there is a distinction in the representations (i.e., feature type frequency vs. feature sharedness) used to categorize across the domain and superordinate level. A second goal was to enrich our representation of the domain level by measuring typicality across both the living/nonliving and animate/inanimate domain classifications and determine which provided a more homogenous distribution.

To address these goals we carried out two studies. In Study 1 we collected superordinate and domain typicality ratings and evaluated their relation to feature sharedness and feature type, while controlling for item familiarity. The expectation was that superordinate typicality would relate to feature sharedness, as previous studies have shown, but domain typicality would relate to feature type, consistent with neuropsychological theories. The particular feature types that correlate with domain typicality should be consistent with feature-based explanations of neuropsychological deficits (i.e., deficits on nonliving items corresponds to deficits in representing functional features whereas difficulties with living items corresponds to deficits in sensory features). Based on neuropsychological work and neuroimaging with healthy participants, we expected typicality across categories of a domain to be more homogeneous under an animate/inanimate division than a living/nonliving one. In Study 2, for those superordinate categories that were judged particularly atypical of their canonical domain category (i.e., fruits and vegetables of Living and vehicles of Inanimate) we reversed their domain category for typicality judgment, to determine whether typicality of living/nonliving or animate/inanimate provides a decisive classification of all superordinates. That is, these categories should be judged worse under the alternative category, if the division provides a decisive categorization.

## STUDY 1

In Study 1, we collected typicality ratings for 10 superordinate categories and the two domain category distinctions (living/nonliving distinction and animate/inanimate distinction). Additionally, we collected familiarity ratings for the basic level exemplars. We evaluated the relation of item typicality to feature sharedness (computed from McRae, Cree, Seidenberg, & McNorgan, 2005 semantic features database) for both superordinate and domain categories, while controlling for item familiarity. Thus, at the superordinate level, we replicated Rosch and Mervis (1975) original study but with familiarity controlled for, and furthermore extended the data to additional categories.

Considering the existing literature that supports a major role for feature sharedness in determining superordinate typicality (Hampton, 1979; Rosch & Mervis, 1975; Verbeemen, et al., 2001), we predicted that typicality would be systematically related to feature sharedness even when partialling out the familiarity effect. Given that the organization of semantic memory across domains has been related to differential dependence on feature types rather than feature sharedness (Cree & McRae, 2003), we predicted that domain typicality would be systematically related to feature type but not to feature sharedness. Nevertheless, in accord with feature-based perspectives of semantic memory that emphasize the role of multiple factors in determining category structure (e.g., Cree & McRae, 2003), it is possible that some feature types may also contribute to superordinate typicality.

## METHOD

### *Participants*

One hundred and four students from the University of Lisbon participated in the study for course credit. Twenty-five students participated in the superordinate typicality rating task, but one participant was excluded because he was not a native speaker of European Portuguese ($n = 24$; average age of 19.44 years, 20 female). Twenty-nine students (average age = 18.68 years; 23 females) participated in the familiarity rating task. Sixty students participated in the domain typicality rating task, and three were excluded, as two were not native speakers of European Portuguese and a third reversed the scale (total *n* = 57; average age = 19.94 years; 42 were female).

## *Materials*

The superordinate categories included for typicality judgment, with number of items in brackets, were: Fruit (26), Vegetables (26), Birds (29), Mammals (34), Vehicles (29), Clothing (30), Weapons (24), Insects (22), Kitchen Utensils (36), and Musical Instruments (25). These same items were presented with the two sets of domain categories: (a) Animate and Inanimate, (b) Living and Nonliving. All category items were presented in Portuguese (see Appendix A for a complete list with English translations and average typicality ratings using the original scale).

## *Procedure*

### *Typicality ratings*

Participants were asked to rate the typicality of the items for each of the 10 superordinate categories. Following Rosch and Mervis (1975), participants judged the item's typicality on a 7-point scale where 1 represents a very good exemplar and 7 a very bad exemplar. Participants were given the option to indicate that they did not know the word by inputting an "N". Each superordinate category was presented in a separate Microsoft Excel worksheet (in a total of 10 worksheets) with the scale at the top of the worksheet and the items listed below and participants were told to indicate their rating in the adjacent column. For superordinate categories, ten randomized lists of items and randomized order of categories were used. For domain typicality ratings, the domain category appeared in a separate Excel worksheet (in a total of 2 worksheets). Each participant only performed typicality ratings for one domain division (i.e., either animate-inanimate or living-nonliving). Approximately half of the participants (*n* = 29) rated the stimuli for typicality of the Animate and Inanimate domains and half (*n* = 28) rated the stimuli for typicality of the Living and Nonliving domains. For domain categories there were 10 randomizations of items and two orders. The instructions closely followed those from the original Rosch and Mervis (1975) study.

### *Familiarity ratings*

Participants were asked to rate the familiarity of the same items from the typicality task. The items were provided in a list on a single Excel worksheet and they were asked to provide a familiarity rating on a scale of 1 to 7, with 1 corresponding to an item they never perceive or produce and 7 corresponding to an item they perceive or produce very frequently. The instructions were adapted from Gilhooly and Logie (1980).

### *Analysis*

For each item, the average typicality and familiarity ratings were calculated for superordinate categorization and independently for each of the two domain divisions. Feature sharedness of each item in the superordinate and domain category was established in the following way. The features associated with each item were taken from the McRae at al. (2005) database. Not all items were included in this database. Thus, the number of items from each category included in the feature sharedness calculation was: Fruit (21), Vegetable (24), Weapon (20), Musical Instrument (16), Kitchen Utensil (15), Vehicle (27), Clothing (28), Bird (28), Insect (11), and Mammal (34). Feature sharedness was calculated in a two-step process. First, for each feature, the total number of items (within the category) with that feature was calculated. This was performed separately across superordinate categories and domain categories. These values per feature were then summed per item. The average typicality (per item) was then correlated with familiarity and subsequently with feature sharedness while partialling out the effect of the item's familiarity. In all results the typicality scale was reversed (i.e., in figures and polarity of correlation coefficients) to be more intuitive (i.e., higher values correspond to more typical items).

Additionally, for each item we computed the total number of feature types from each class listed in the Cree and McRae (2003) brain-region feature type taxonomy. In the McRae et al. (2005) feature database, each feature is classified with a given feature type. Brain region feature labels fall into one of four categories: (a) Visual information, (b) Other sensory channel, (c) Functional/motor, and (d) Other. Within the Visual Information category there are the feature labels Visual-Colour, Visual-Form and Surface, and Visual-Motion. Within other sensory channels there are Smell, Sound, Taste, and Tactile information. Within Functional/Motor there are features about Function. Finally, within Other there is Encyclopaedic and Taxonomic information. For each item, the total number of instances of each feature label was calculated. The summed feature types were then correlated with typicality for each of the superordinate categories.

## RESULTS

### *Superordinate Typicality*

There was a weak, though significant correlation, between familiarity and typicality ($r = 0.17$, $p = 0.01$). The more typical the item, the more familiar the item was. Given that it was not a very strong effect, we can further conclude that the two are to a large degree independent. Nonetheless, this weak correlation warrants partialling out familiarity from the correlation between typicality and feature sharedness.

### *Superordinate Typicality and Feature Sharedness*

All superordinate categories with the exception of birds, mammals, and musical instruments demonstrated a significant correlation between typicality and degree of shared features (see Table 1 for a list of the partial correlation coefficients and their significance). Significant positive correlations indicate that the more typical the item the greater the amount of features shared with other category members. The three categories that did not demonstrate a significant correlation were also the categories with the lowest variability in typicality scores. The same correlations were calculated without controlling for familiarity, demonstrating little difference in the strength of the relationship (see Table 1). This finding is consistent with the weak relationship between typicality and familiarity.

### ***Superordinate Typicality and Feature Type***

Superordinate typicality did not correlate with many feature types, i.e., on average only one feature per category (see Table 2 for a list of feature types that significantly correlated with typicality of each superordinate category).

Table 1
*Original and Partial correlations (i.e. controlling for familiarity) between superordinate typicality and feature sharedness.*

| Category (N) | Original Correlations | Partial Correlations | Typicality Mean (SD) |
|---|---|---|---|
| Bird (28) | .07 | .06 | 2.09 (0.64) |
| Clothing (28) | .67** | .68** | 3.24 (1.53) |
| Fruit (21) | .50* | .47* | 1.97 (1.14) |
| Insect (11) | .68* | .70* | 2.66 (1.17) |
| Kitchen Utensil (15) | .67** | .67** | 2.55 (1.03) |
| Mammal (34) | .25 | .29 | 2.23 (0.76) |
| Musical Instrument (16) | .23 | .28 | 2.12 (0.94) |
| Vegetable (24) | .70** | .71** | 2.60 (1.09) |
| Vehicle (27) | .54** | .41* | 3.26 (1.70) |
| Weapon (20) | .75** | .76** | 2.99 (1.72) |

*Note*. ** $p$ <.01; * $p$ <.05

Further superordinate typicality did not correlate systematically with feature type across categories belonging to each domain. There were some additional marginal effects (Fruit: Taxonomic $r$ = -0.42, $p$ = .07; Vegetables: Encyclopaedic $r$ = .39, $p$ = .07; Clothing: Function, $r$ = -.33, $p$ = .10; Weapons: Visual-motion, $r$ = .42, $p$ = .07).

Table 2
*Partial correlation coefficients between superordinate typicality and feature type, controlling for familiarity, with the corresponding p-values.*

| Category | Feature Types | *r* , *p* |
|---|---|---|
| Bird (28) | Encyclopedic | *r* = -0.52, *p* = 0.01 |
| Clothing (28) | Visual colour | *r* = 0.44, *p* = 0.02 |
| Fruit (21) | Function | *r* = -0.56, *p* = 0.01 |
| Insects (11) | Visual-form and surface | *r* = .64, *p* = .05 |
| Kitchen Utensil (15) | | |
| Mammal (34) | | |
| Musical Instrument (16) | Taxonomic | *r* = -.74, *p* = .001 |
| Vegetable (24) | | |
| Vehicles (27) | Taxonomic | *r* = 0.39, *p* = 0.05 |
| Weapon (20) | Encyclopaedic | *r* = 0.53, *p* = 0.02 |
| | Sound | *r* = .59, *p* = 0.01 |
| | Tactile | *r* = -0.55, *p* = 0.011 |

## *Domain Division and Typicality Ratings*

The average typicality ratings by superordinate category for the Nonliving/Living, and Inanimate/Animate domains are presented in Figure 2, and 3, respectively.

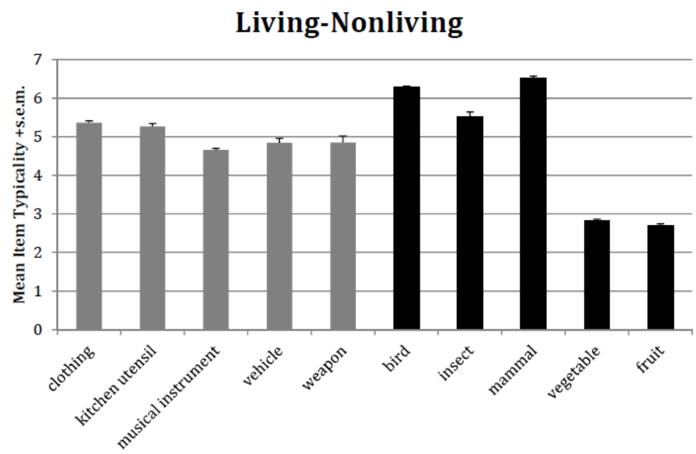


*Figure 2*. Average typicality of Living and Nonliving domain by item broken down by superordinate.

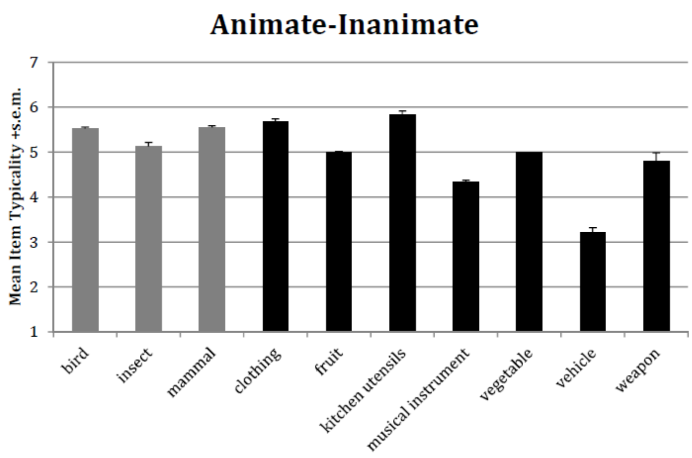

*Figure 3*. Average typicality of Animate and Inanimate domain by item broken down by superordinate category.

A striking feature from these graphs is the atypicality of fruits and vegetables of the living category. This contrast does not appear in the typicality of the inanimate domain, where fruits and vegetables demonstrate an average typicality, situated near the middle of the distribution. Hence, the animate/inanimate division allows for more homogenous typicality ratings.

### *Domain Typicality and Feature Sharedness*

Evidence that typicality at the domain level is related to a different variable than at the superordinate level is provided by multiple results. Domain typicality does not correlate with familiarity (Animate/Inanimate: $r = -.10$, $p = .15$; Living/Nonliving: $r = -.06$, $p = .42$), unlike superordinate typicality. Second, and most convincingly, domain typicality does not relate to feature sharedness (Animate: $r = -.15$, $p =. 36$; Inanimate: $r = -.08$, $p = .42$; Living: $r = -.03$, $p = .80$; Nonliving: $r = -.32$, $p = .01$). The only exception to this is the nonliving domain. However, here the correlation is negative, which is in the opposite direction to that found for the superordinate level. This means that the more features shared by members of the nonliving domain, the less typical they are.

It is worth noting that the features used in the feature sharedness calculation are features of the basic level concept (e.g., apple) and not of the superordinate level (e.g., fruit). Given that we asked for typicality ratings for basic level concepts within domain categories, it made the most sense to likewise take the features from that same basic level concept. Nonetheless, averaging typicality across superordinate categories did indicate differences at this level. Perhaps future work may want to study the relationship between domain typicality (of a superordinate concept) and features collected at the superordinate level (e.g., Marques, 2007) to determine whether the same results hold.

### *Domain Typicality and Feature Type*

Correlations between domain typicality and feature type (i.e., a broader aspect of features) demonstrated that typicality correlated with the frequency of particular feature types (see Tables 3, 4 and 5). There are a couple lessons that can be taken from these feature type correlations. First, the number of features that correlate with the animate/inanimate categories is less than that for the living/nonliving categories. The simpler feature explanation of animate/inanimate favours such a domain division over a living/nonliving one. Second, the features that correlate with typicality at the nonliving and inanimate level are very similar (e.g., tactile, sound, visual-motion). The domains seem to be most distinguished at the living and animate levels, where living has many more features that relate to typicality. Animate and living are similar in that the more "function" features an item has, the less typical it is and the more "sound" features an item has, the more typical it is. They diverge on other features.

They demonstrate opposite relationships with visual-form surface features, and the more "smell" feature type the item has, the less typical the item is of the animate category, whereas, for living, the more "taste", "visual-colour", and "tactile" features the more typical it is of living.

Interestingly, the features usually associated with each domain (i.e., animate/living: perceptual, inanimate/nonliving: functional) were inverted in terms of their relation to typicality. Both animate/living domains correlated negatively with "function" features; meaning that the more functions features an item had (e.g., sheep), the less typical it was of the animate/living domain. Likewise, inanimate/nonliving negatively correlated with visual motion features. Again, the more visual-motion features (e.g., rocket), the less typical the item was of that domain. It is important to note however, that on average, the animate/living domain items had more "visual motion" features than the inanimate/nonliving domain items and similarly, on average the inanimate/nonliving items had more "function" features. Rather than those feature types that are critical for the representation of a domain correlating with typicality, it seems (more often) to be the case that the more features associated with the alternative domain classification, the less typical the item is.

Table 3

*Correlation between Animate and Inanimate typicality and Feature Types controlling for familiarity of the items.*

| Feature Type | *r* | *p* |
|---|---|---|
| | Animate Domain | |
| Encyclopaedic | .06 | .72 |
| Function | -.35 | .03 |
| Smell | -.35 | .03 |
| Sound | .45 | .00 |
| Tactile | .22 | .18 |
| Taste | - | - |
| Taxonomic | -.03 | .85 |
| Visual-Colour | -.23 | .16 |
| Visual-Form-Surface | -.32 | .05 |
| Visual-Motion | .20 | .21 |
| | Inanimate Domain | |
| Encyclopaedic | -.13 | .20 |
| Function | -.00 | 1.00 |
| Smell | .06 | .58 |
| Sound | -.34 | .001 |
| Tactile | .43 | <.001 |
| Taste | .13 | .19 |
| Taxonomic | .26 | .01 |
| Visual-Colour | .20 | .04 |

| | | |
|---|---|---|
| Visual-Form-Surface | -.07 | .50 |
| Visual-Motion | -.56 | <.001 |

### *Superordinate Typicality by Domain and Domain Typicality Relations to Feature Type*

The feature types that correlate with superordinate categories (in conjunction with considering direction of correlation) are quite different from those seen for their domains. For instance, within the animate category at the superordinate level only the Encyclopaedic feature type correlated with typicality of being a bird. This feature type is not observed at the domain level of the animate category. Within the inanimate category, there was some consistency in that Visual-Colour and Taxonomic features correlated with typicality of clothing and vehicles, respectively, and in the same direction as was observed for the domain level, but overall there is great divergence in the feature types that correlate with superordinate and domain typicality.

Table 4
*Correlation between Living and Nonliving typicality and Feature Types controlling for familiarity of the items.*

| Feature Type | *r* | *p* |
|---|---|---|
| | Living | |
| Encyclopaedic | .20 | .08 |
| Function | -.55 | <.001 |
| Smell | .00 | .99 |
| Sound | .49 | <.001 |
| Tactile | -.40 | <.001 |
| Taste | -.69 | <.001 |
| Taxonomic | .52 | <.001 |
| Visual-Colour | -.40 | <.001 |
| Visual-Form-Surface | .28 | .01 |
| Visual-Motion | .76 | <.001 |
| | Nonliving | |
| Encyclopaedic | -.15 | .26 |
| Function | .09 | .49 |
| Smell | -.01 | .93 |
| Sound | -.53 | <.001 |
| Tactile | .48 | <.001 |

| | | |
|---|---|---|
| Taste | - | - |
| Taxonomic | .11 | .41 |
| Visual-Colour | 14 | .30 |
| Visual-Form-Surface | .06 | .66 |
| Visual-Motion | -.33 | .01 |

## DISCUSSION

The results replicate and extend the effect first found by Rosch and Mervis (1975). The more typical an item is of its superordinate category the more features it shares with other members of the category. The reason that Mammals, Birds, and Musical Instruments did not demonstrate such a relationship seems most likely related to the fact that these categories had the lowest variability in typicality (less than 1 standard deviation) across category members. It is interesting to note that two of the three categories are animate, potentially indicating that there is less variability in the feature overlap for the categories that have a more scientific standing, which is particularly true of the "mammals" category.

Table 5
*Summary of feature types significantly correlated with domain categories when controlling for familiarity.*

| Domain | Negative correlations | Positive correlations |
|---|---|---|
| Animate | Function | Sound |
| | Smell | |
| | Visual-form-surface | |
| Inanimate | Sound | Tactile |
| | Visual-motion | Taxonomic |
| | | Visual-colour |
| Living | Function | Sound |
| | Tactile | Taxonomic |
| | Taste | Visual-form-surface |
| | Visual-colour | Visual-motion |
| Nonliving | Sound | Tactile |
| | Visual-motion | |

While the mammal category demonstrates a relation to feature sharedness that is in the expected direction, and approaching significance, the bird category does not correlate with feature sharedness in the expected direction. In looking at this category more carefully, it is apparent that the atypical exemplars also tend to have more features.

This can inflate the family resemblance measure for these exemplars. In fact the correlation between number of features and typicality is significant for this category, consistent with the results from Malt & Smith (1982).[3]

The correlation coefficients between typicality and family resemblance tend to be lower than those reported by Rosch and Mervis (1975). There are two possible reasons for this: (a) Rosch and Mervis (1975) did not control for familiarity, as we did and/or (b) we used a feature database (McRae et al., 2005), whereas Rosch and Mervis (1975) had their own participants provide the feature information. The analyses can speak to these possibilities. The correlation between typicality and feature sharedness without partialling out the effect of familiarity had little effect on the values. Thus, the difference between our correlation values and those of Rosch and Mervis (1975) is most likely related to the method by which feature data was obtained in the two studies. To elaborate on this point, Rosch and Mervis had their participants generate features for each exemplar. Following that, different participants indicated whether or not every feature (generated across all exemplars) applied to every exemplar. The McRae et al. (2005) database features were not judge amended in this way. Nonetheless, the clear replication of previous results validates the use of the feature production norms and demonstrates their reliability.

In examining the correlation between superordinate typicality and feature type, it is interesting to note that few features (0-3) correlate with typicality within each superordinate category and that the most consistent feature observed across the categories is ‘Taxonomic’. Few categories correlate with perceptual or functional features, which traditionally were associated with the living vs. nonliving domain distinction observed in the neuropsychological literature. This is not the case for domain typicality discussed below.

Considering domain typicality, greater homogeneity in typicality ratings was observed across the animate/inanimate distinction than the living/nonliving. A further direct test of this will be provided in Study 2, and to anticipate those results, they are consistent with those provided here. Domain typicality did not correlate with feature sharedness, indicating different principles of categorization at more general levels of categorization and at the more specific levels. Domain typicality, unlike superordinate typicality, demonstrated an interesting relation with those features that have standardly been associated with the representation of domain categories. Typicality did not necessarily correlate with those features standardly associated with that domain, but rather typicality of the alternative domain category did. For instance, “Functional” features standardly associated with the nonliving/inanimate domain were indeed on average higher for Nonliving/Inanimate items. However, typicality of items from those categories did not correlate with the number of “Function” features associated with an item, but rather typicality of the alternative living/animate domains did. Specifically, the more “function” features attributed to an item, the less typical it was of the living/animate domains. Similarly, “Visual Motion” features were on average higher in animate/living domains, but did not correlate with animate typicality. Instead, it correlated with inanimate typicality; whereby the more “visual motion” features the item had, the less typical it

[3] Barsalou (1985) found typicality correlated with central tendency for the bird category. Central tendency looks at the average similarity of an exemplar to other category members, but does not directly consider number of features. In our study, the number of features for the atypical birds seems to have biased their “family resemblance” scores.

was of the inanimate category. Animate and Living categories were distinguished in that living items also correlated with visual-motion features (the more visual-motion features, the more typical).

The feature type correlations, at domain level, demonstrated that the nonliving/inanimate categories had a very similar feature type relationship; the more “sound” and “visual-motion” features, the lower the domain typicality of the item, but the more “tactile” features the more typical of the domain the item was. The animate domain had a simpler feature type relation than the living one. They demonstrated overlap in that the more “Function” features, the less typical of the animate/living categories, but the more “sound” features, the more typical the item was of those domains. However, they were distinguished by “visual-form surface” features negatively correlating with animate typicality (more visual-form surface features were associated with less typical items), but correlating positively with inanimate typicality (more visual-form surface were associated with more typical items).

In summary, we replicated previous findings of a relationship between superordinate category typicality and feature sharedness using feature production norms. Given this replication, we used the same norms in studying a relationship between domain typicality and feature sharedness, which turned out to be not significant. Rather, domain typicality correlated with frequency of feature types, whereby domain typicality negatively correlated with features previously associated with the alternative domain category. The inanimate and nonliving categories were largely consistent in their feature correlations, whereas the animate and living categories demonstrated less overlap in their feature correlation. This was due to more features correlating with typicality in the living category. Both the more homogenous typicality ratings and the simpler feature analysis for the animate-inanimate distinction provide support for this division.

## STUDY 2

In Study 1 the superordinate categories of fruits and vegetables scored on average very atypically of the living domain relative to the other superordinate categories in that domain. The vehicles category was also atypical within the inanimate domain compared to the other superordinate categories. In Study 2 we ran an additional typicality judgment study to investigate if the living-nonliving domain in fact distinguishes between fruits and vegetables and whether the animate-inanimate domain distinguishes between vehicles. Thus the goal of this study was to clarify if one domain distinction provides better categorization for all superordinates or whether the best domain categorization depends on the superordinate category. If typicality for fruits and vegetables does not differ between the living and nonliving categories, but vehicles are more typical of the inanimate category, then we would have support for the animate-inanimate distinction. In the case that both fruit/vegetables and vehicles do not categorize better as living or nonliving and animate or inanimate, respectively, there would be no preferable domain distinction, as both would be better suited for particular superordinates and in fact this might provide indirect support for a tripartite distinction.

## METHOD

### *Participants*

Thirty three students of the University of Lisbon participated in the study for course credit. Two were excluded because they either did not complete the entire session, or completed with only one number judgment (i.e., 7).

### *Materials*

The same items were used as in Study 1.

### *Procedures*

We followed the same procedure as in Study 1, with the modification that fruits and vegetables appeared in the Nonliving category for those participants performing typicality judgment for the living/nonliving domains ($n$ = 13) and vehicles appeared in the animate category for those participants performing typicality judgments across the animate/inanimate domains ($n$ = 18).

### *Analysis*

The typicality data from the Living and Nonliving domains were compared with that in Study 1 in a 10 Within (Category) × 2 Between (Fruit or Vegetable-Living, Fruit or Vegetable-Nonliving) ANOVA, whereby typicality data was averaged by participant. The goal of this analysis was to investigate whether Fruits and Vegetables were more typical of the Living or of the Nonliving domain. Similarly, the typicality data from the Animate and Inanimate domains were compared with those in Study 1 in a 10 Within (Category) × 2 Between (Vehicle-Animate, Vehicle-Inanimate) ANOVA to explore if Vehicles were more typical of the Animate or the Inanimate domain.

## RESULTS

As can be seen from the typicality graphs (see Figure 4 and Figure 5), the typicality of fruits and vegetables in the Nonliving domain is approximately equivalent to that in the Living domain from Study 1. However, the typicality of vehicles in the Animate domain is lower than when in the Inanimate domain.

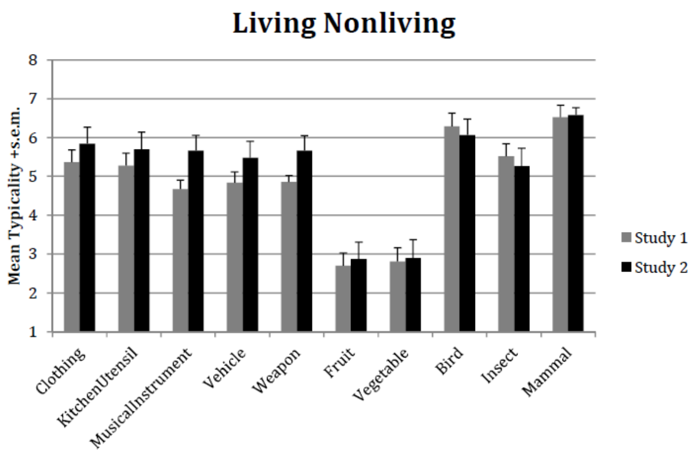


*Figure 4*. Average typicality of Living-Non-living domain in Study 1 and 2 by participant. In Study 1, fruits and vegetables were judged for typicality in the Living domain (grey bars) and in Study 2 they were judged in the non-living category (black bars).

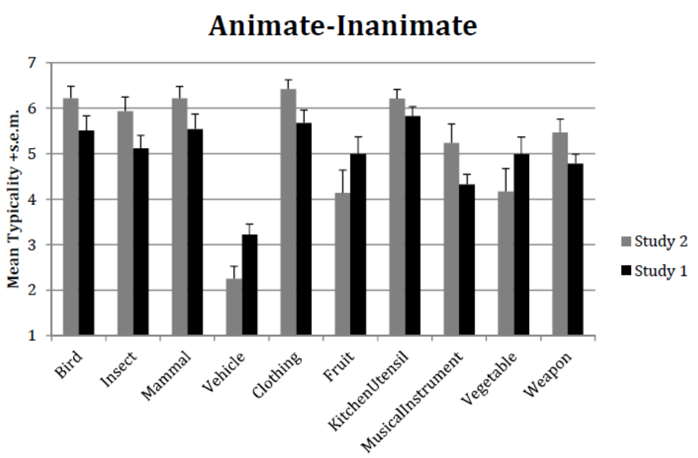


*Figure 5*. Average typicality of Inanimate-Animate domain in Study 1 and 2 by participant. In Study 1, the vehicle category was judged for typicality in the inanimate domain (grey) and in Study 2 and the animate domain (black bars).

In comparing the typicality data from the Living-Nonliving domains across Study 1 and 2, there was no significant interaction between Study and Category ($p$ = .25, $\eta^2_p$ = 0.03), nor a significant effect of Study ($p$ = .41, $\eta^2_p$ = .02). These results indicate that Fruits and Vegetables were equally typical (or more accurately atypical) of the Living and Nonliving categories. On the other hand, there was a significant interaction for the Animate-Inanimate domains ($F$(9, 405) = 4.19, $p < .001$, $\eta^2_p$ = 0.08). The interaction was due to an effect across Study 1 and 2 for the categories Vehicle ($p$ = .01) and Musical Instrument ($p$ = .04), where Vehicles were rated less typical when included in the Animate domain than the Inanimate domain, and Musical Instruments were rated more typical in Study 1 than in Study 2. Weapons demonstrated a similar trend that was marginally significant ($p$ = .06). The main effect of Study was not significant ($p$ = .43, $\eta^2_p$ = .01).

## DISCUSSION

The results from Study 2 demonstrate that fruits and vegetables are not more typical of the Living than of the Nonliving domain. This demonstrates that the Living-Nonliving domain does not provide a good classification for fruits and vegetables. The finding that vehicles are more typical when included in the inanimate than the animate domain indicates that the Animate-Inanimate domain classification provides a reliable classification system for even its most atypical category member.

The fact that fruits and vegetables were equally typical/atypical of the living and non-living categories may be construed as an artefact of them representing only *part* of a living entity. That is, the fruit may be considered living when attached to the tree, but may not be considered living once detached. Given that in this task participants judged the typicality of the fruit and not the tree, this hypothesis would imply that they should be *more* typical of the nonliving category than of the living. Alternatively, one may argue that participants could be confused about whether they should consider the fruit as attached to the tree or not. While this may be the case, it seems unlikely that that is what the participants were indecisive about. First, no subject raised this question (i.e., should they consider it attached to the tree or not) and, secondly, our typical experiences with fruit are in the state of being detached from the tree, so it is most likely that the participants were only considering this state. Thus, it is very likely that participants are unsure about the “living” status of fruits and vegetables when detached from the tree, indicating that this division is not a primitive of (explicit) semantic categorization.

The case of vehicles, which were relatively atypical of the inanimate category, relates to a body of work relating animacy to self-generated motion (Massay & Gelman, 1988). The relevance of self-generated motion to animacy may be why vehicles score more atypical of the inanimate domain than the other superordinates, which are not capable of motion, self-generated or otherwise. Nonetheless, the animate/inanimate division distinguished vehicles in terms of typicality. In consideration of the results from fruits/vegetables above, it seems that the animate-inanimate division is a more fundamental category division.

The difference in typicality of Musical Instruments across Studies 1 and 2 was due to a higher typicality in the second study, which was a general trend across categories. Thus, the effect of vehicles that showed lower typicality in the second study is unlikely to be due to a general study effect. Lastly, these results generally show that typicality ratings are reliable over studies.

In summary, the domain division that provides the clearest categorization is the animate/inanimate one, consistent with the conclusions from category-specific deficits.

## GENERAL DISCUSSION

The two studies reported here elaborate on the representation of semantic memory. The reliability of previous typicality findings at the superordinate level is provided by the fact that we replicated the effect originally found by Rosch and Mervis (1975) whereby more typical items shared more features with other category members. We extend the results of Rosch and Mervis (1975) by showing that this relation holds when controlling for familiarity and when using feature production norms. This study provides novel data concerning the structure of the domain level. At the domain level, typicality ratings reflect an organizational principle distinct from that at the superordinate level, given that typicality across these two levels demonstrated distinct relations with familiarity, feature sharedness and frequency of feature types.

The independence of typicality rating correlates at the superordinate and domain levels implies some degree of dissociation in their implementation. This dissociation between categorization at the domain, or more general levels, and the superordinate, or more specific levels, is supported by neuropsychological studies. These include the category specific deficit patients previously discussed, as well as patients with semantic dementia (SD). SD patients tend to have rather focal atrophy to anterior temporal regions and demonstrate impairments to naming at more specific levels, such as the members of superordinate categories, but sparing at more general levels (Rogers & Patterson, 2007). Moreover, testing SD patients' knowledge or perception of superordinate members demonstrates preservation of knowledge for those features that are highly shared among category members or representative of more general level categories. For example, Bozeat et al. (2003) showed that drawings in SD patients resulted in representations that were more prototypical than the target items, as the items' distinctive features were absent. For example, given a picture of a camel to draw, SD patients may draw an animal that resembles a horse, lacking the specific feature (i.e., hump) that makes a camel distinct. Likewise, SD patients correctly verify sentences about more shared features of superordinate concepts, while making more errors for less shared features (Marques & Charnallet, 2013). For example, they can tell that mammals develop inside the mother's womb while having difficulties in admitting that some mammals live at sea. Thus, in SD there is a sparing of more general categories and shared features (at these levels) with impairment of more specific/distinctive knowledge (i.e., specific categories and features). Our results show that these two factors (hierarchical level and feature sharing) should not be conflated, as domain typicality did not relate to feature sharedness. Rather, domain typicality related to frequency of particular feature types. Thus, when speaking about general to specific information in semantic memory, one can refer to both hierarchical category levels and feature sharedness. Across levels, the general to specific information seems to refer to features, running from the broad feature type (i.e., domain level) through to the more specific features (i.e., the *canoe* category requires more specific features than the *boat* category).

Our results also have implications for categorization processes. While superordinate categories depend on identifying the degree of feature similarity across members, the domain level seems to abstract away from the specific features to the presence and frequency of feature types, which should not require a comparison across members. Presumably, once some threshold of frequency is reached, or lack of threshold, categorization can occur. Thus, while both domain and superordinate categorization require access to features (or properties thereof), the domain level simply considers their type, but the superordinate level requires those features be compared across members. It is this comparison process that seems to critically distinguish the two levels in categorization.

Though, as was mentioned previously, feature sharedness should also be considered at the superordinate level in future studies.

The factors that determine the typicality of the item to be categorized seem to be complex. Typicality of superordinate categories relates to the feature sharing within the category and also, based on previous work, to the lack of feature sharing with alternative categories. Typicality at domain level may correlate with frequency of feature types most critical to the representation of that domain category, but it even more often correlates with the frequency of feature types commonly associated with the alternative domain category. That is, the more features implicated in the representation of the alternative domain category (e.g., animate), the less typical the concept is of its domain category (inanimate). Clearly there are similarities in what determines typicality, but what seems to be more important for superordinate typicality is within category feature sharedness, whereas for domain typicality it seems to be more affected by the presence (or absence) of features that are more pervasive in the alternative domain category.

Finally, the typicality ratings favoured an Animate-Inanimate classification at the domain level, by showing more homogenous ratings across this classification than the Living-Nonliving one, mainly due to the atypicality of the Fruits and Vegetables categories within the Living category. This was further substantiated, by showing that Fruits and Vegetables did not categorize better (or worse), as either Living or Nonliving. This was not true of the most atypical category (i.e., vehicles) in the animate/inanimate domain. Convergence across studies involving patients with specific deficits, neuroimaging of healthy participants and typicality judgments indicates that animate/inanimate provides better domain classification (Kriedgeskorte et al., 2008, Caramazza & Shelton, 1998). This is not to say that our conceptual system does not make reference to the living/nonliving distinction, but that animate/inanimate is more fundamental and provides a clearer division of objects in the world. This finding has an implication for the neurological implementation of semantic categories. Predictions can be made about expected deficits in patients and localization of activation in healthy persons. For instance, it is more likely to expect deficits to fruits and vegetables alongside deficits to other inanimates, than deficits to other animates, and indeed this has previously been reported (Hillis & Caramazza, 1991).

In conclusion, the typicality data collected here provide two main conclusions: (a) superordinate and domain levels of categorization are based on relatively distinct semantic information and (b) the animate-inanimate classification is the most appropriate domain organization. At the domain level, categorization occurs along the animate/inanimate distinction based on processes that consider feature type frequency rather than feature sharedness.

## REFERENCES

Ameel, E., & Storms, G. (2006). From prototypes to caricatures: Geometrical models for concept typicality. *Journal of Memory and Language, 55*, 402-421.

Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*, 629-654.

Bozeat, S., Lambon Ralph, M. A., Graham, K. S., Patterson, K., Wilkin, H., Rowland, J., . . . Hodges, J. R. (2003). A duck with four legs: Investigating the structure of conceptual knowledge using picture drawing in semantic dementia. *Cognitive Neuropsychology, 20*, 27-47.

Capitani, E., Laiacona, M., Mahon, B., & Caramazza, A. (2003). What are the facts of category-specific deficits? A critical review of the clinical evidence. *Cognitive Neuropsychology, 20*, 213-262.

Caramazza, A., & Shelton, J. R. (1998). Domain specific knowledge systems in the brain: The animate-inanimate distinction. *Journal of Cognitive Neuroscience, 10*, 1-34.

Casey, P. J. (1992). A reexamination of the roles of typicality and category dominance in verifying category membership. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 823-834.

Coley, J. D., Medin, D. L., & Atran, S. (1997). Does rank have its privilege? Inductive inferences within folkbiological taxonomies. *Cognition, 64,* 73-112.

Cree, G. S., & McRae, K. (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General, 132*, 163-201.

Dry, M. J., & Storms, G. (2010). Features of graded category structure: Generalizing the family resemblance and polymorphous concept models. *Acta Psychologica, 133*, 244-255.

Gilhooly, K. J., & Logie, R. H. (1980). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behavior Research Methods & Instrumentation, 12*, 395-427.

Glass, A. L., & Meany, P. J. (1978). Evidence for two kinds of low-typical instances in categorization task. *Memory and Cognition, 6*, 622-628.

Hampton, J. A. (1979). Polymorphous concepts in semantic memory. *Journal of Verbal Learning and Verbal Behavior, 18,* 441-461.

Hillis, A. E., & Caramazza, A. (1991). Category specific naming and comprehension impairment: A double dissociation. *Brain, 114,* 2081-2094.

Holmes, S. J., & Ellis, A. W. (2006). Age of acquisition and typicality effects in three object processing tasks. *Visual Cognition, 13*, 884-910.

Johnson, K. E., & Mervis, C. B. (1997). Effects of varying levels of expertise on the basic level of categorization. *Journal of Experimental Psychology: General, 126,* 248-277.

Kiran, W., Ntourou, K., & Eubank, M. (2007). The effectof typicality on online category verification of inanimate category exemplars in aphasia. *Aphasiology, 21*, 844-866.

Kriedgeskorte, N., Mur, M., Ruff, D. A., Kiani, R., Bodurka, J., Esteky, H., . . . Bandettini, P. A. (2008). Matching categorical object representations in inferior temporal cortex of man and monkey. *Neuron, 60*, 1126-1141.

Larochelle, S., & Pineau, H. (1994). Determinants of response times in the semantic verification task. *Journal of Memory and Language, 33*, 796-823.

Lin, E. L., Murphy, G. L., & Shoben, E. J. (1997). The effects of prior processing episodes on basic-level superiority. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 50,* 25-48.

Malt, B. C., & Smith, E. E. (1982). The role of familiarity in determining typicality. *Memory and Cognition, 10*, 69-75.

Marques, J. F. (2002). An attribute is worth more than a category: Testing different semantic memory organization hypotheses to the living/nonliving things dissociation. *Cognitive Neuropsychology, 19,* 463-478.

Marques, J. F. (2005). Naming from definition: The role of feature type and feature distinctiveness *The Quarterly Journal of Experimental Psychology, 58,* 603-611.

Marques, J. F. (2007). The general/specific breakdown of semantic memory and the nature of superordinate knowledge: Insights from superordinate and basic level feature norms. *Cognitive Neuropsychology, 24*, 879-903.

Marques, J. F., & Charnallet, A. (2013). The role of feature sharedness in the organization of semantic knowledge: Insights from semantic dementia. *Neuropsychology, 27,* 266-274.

Marques, J. F., & Morais, J. (2000). The relations between typicality, category membership, and familiarity: A study using proactive interference. *Cahiers de Psychology Cognitive/Current Psychology of Cognition, 17*, 683-707.

McCloskey, M. E. (1980). The stimulus familiarity problem in semantic memory research. *Journal of Verbal Learning and Verbal Behavior, 19*, 485-502.

McCloskey, M. E., & Glucksberg, S. (1978). Natural categories: Well defined or fuzzy sets? *Memory and Cognition, 6,* 462-472.

McRae, K., Cree, G. S., Seidenberg, M. S., & McNorgan, C. (2005). Semantic feature production norms for a large set of living and nonliving things. *Behavior Research Methods, Instruments, & Computers, 37*, 547-559.

Mervis, C. B., Catlin, J., & Rosch, E. (1976). Relationships among goodness-of-example, category norms and word frequency. *Bulletin of the Psychonomic Society, 7*, 283-284.

Mervis, C. B., & Rosch, E. (1981). Categorization of natural objects. *Annual Review of Psychology, 32*, 89-115.

Murphy, G. (2004). *The big book of concepts.* Cambridge, MA: MIT Press.

Massay, C., & Gelman, R. (1988). Preschoolers' ability to decide whether pictured unfamiliar objects can move themselves. *Developmental Psychology, 24,* 307-317.

Rakison, D. H., & Poulin-Dubois. (2001). Developmental origin of the animate-inanimate distinction. *Psychological Bulletin, 127*, 209-228.

Raposo, A., Mendes, M., & Marques, J. F. (2012). The hierarchical organization of semantic memory: Executive function in the processing of superordinate concepts. *NeuroImage, 59,* 1870-1878.

Rogers, T. T., & Patterson, K. (2007). Object categorization: Reversals and explanations of the basic-level advantage. *Journal of Experimental Psychology: General, 136*, 451-469.

Rosch, E. (1975a). Cognitive reference points. *Cognitive Psychology, 7,* 532-547.

Rosch, E. (1975b). Cognitive representations of semantic categories. *Journal of Experimental Psychology: General, 104*, 192-233.

Rosch, E. (1975c). The nature of mental codes for color categories. *Journal of Experimental Psychology: Human Perception and Performance, 1*, 303-322.

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structural of categories. *Cognitive Psychology, 7,* 573-605.

Rosch, E., Simpson, C., & Miller, R. S. (1976). Structural bases of typicality effects. *Journal of Experimental Psychology: Human Perception and Performance, 2*, 491-502.

Smith, E. E., Shoben, E. J., & Rips, L. J. (1974). Structure and process in semantic memory: A featural model of semantic association. *Psychological Review, 81*, 214-241.

Smyth, M. M., Collins, A. F., Morris, P. E., & Levy, P. (1994). *Cognition in Action* (2nd ed.): Hillsdale, NJ: Lawrence Erlbaum.

Verbeemen, T., Vanoverberghe, V., Storms, G., & Ruts, W. (2001). The role of contrast categories in natural language concepts. *Journal of Memory and Language, 44*, 618-643.

Warrington, E. K., & McCarthy, R. A. (1987). Categories of knowledge: Further fractionations and an attempted integration. *Brain, 110*, 1273-1296.

Warrington, E. K., & Shallice, T. (1984). Category specific semantic impairment. *Brain, 107*, 859-878.

Wellman, H. M., & Gelman, S. A. (1998). Knowledge acquisition in foundational domains. In D. Kuhn & R. S. Siegler (Eds.), *Handbook of child psychology* (pp. 523-573). New York, NY: Wiley.

Wittgenstein, L. (1953). *Philosophical investigations.* Oxford, UK: Blackwell.

Woollams, A. M., Cooper-Pye, E., Hodges, J. R., & Patterson, K. (2008). Anomia: A doubly typical signature of semantic dementia. *Neuropsychologia, 46*, 2503-2514.

Zannino, G. D., Perri, R., Carlesimo, G. A., Pasqualetti, P., & Caltagirone, C. (2002). Category-specific impairment in patients with Alzheimer's disease as a function of disease severity: a cross-sectional investigation. *Neuropsychologia, 40*, 2268-2279.

# APPENDIX A

Presents the category label, item name in Portuguese, item name translated to English, typicality at the supordinate level (SO Typicality), typicality at the animate-inanimate domain level (IA Typicality), and typicality at the living-nonliving domain level (LV Typicality). The typicality scale is from 1-7, where 1 is most typical and 7 least typical.

| Category | SO Item | English | SO Typicality | IA Typicality | LV Typicality |
|---|---|---|---|---|---|
| Fruit | Abacate | Avocado | 3.2500 | 3.0000 | 5.3214 |
| Fruit | Alperce | Apricot | 1.4783 | 2.9655 | 5.3929 |
| Fruit | Ameixa | Plum | 1.2083 | 3.0000 | 5.2857 |
| Fruit | Amora | Blueberry | 1.6667 | 3.0345 | 5.1786 |
| Fruit | Ananás | Pineapple | 1.4583 | 3.0690 | 5.2143 |
| Fruit | Azeitona | Olive | 5.3750 | 2.8966 | 5.6786 |
| Fruit | Banana | Banana | 1.0833 | 2.9655 | 5.1786 |
| Fruit | Cereja | Cherry | 1.1250 | 3.0345 | 5.2500 |
| Fruit | Coco | Coconut | 2.2500 | 2.7931 | 5.2857 |
| Fruit | Framboesa | Raspberry | 1.7083 | 3.1379 | 5.6071 |
| Fruit | Ginja | Cherry | 4.1304 | 3.3103 | 5.4000 |
| Fruit | Kiwi | Kiwi | 1.6250 | 3.0345 | 5.4286 |
| Fruit | Laranja | Orange | 1.0000 | 2.9655 | 5.3571 |
| Fruit | Lima | Lime | 3.5833 | 3.0000 | 5.3929 |
| Fruit | Limão | Lemon | 3.0833 | 3.0345 | 5.3571 |
| Fruit | Maçã | Apple | 1.0000 | 2.9310 | 5.3214 |
| Fruit | Melão | Cantaloupe | 1.3750 | 3.0345 | 5.1071 |
| Fruit | Morango | Strawberry | 1.1250 | 2.8621 | 5.1786 |
| Fruit | Nectarina | Nectarine | 2.4783 | 3.1034 | 5.3333 |
| Fruit | Nêspera | Medlar | 1.6667 | 3.0345 | 5.1786 |
| Fruit | Pêra | Pear | 1.0417 | 3.0345 | 5.2857 |
| Fruit | Pêssego | Peach | 1.0000 | 2.9655 | 5.1786 |
| Fruit | Tâmara | Date | 3.2083 | 3.1034 | 5.4400 |
| Fruit | Tangerina | Tangerine | 1.1667 | 3.0000 | 5.0000 |
| Fruit | Toranja | Grapefruit | 2.0417 | 2.9655 | 5.3214 |
| Fruit | Uva | Grape | 1.1667 | 2.8621 | 4.9286 |
| Vegetable | Abóbora | Pumpkin | 3.0000 | 2.8966 | 5.1071 |
| Vegetable | Aipo | Celery | 2.1667 | 3.1250 | 5.2609 |
| Vegetable | Alface | Lettuce | 1.7917 | 2.9655 | 4.8571 |
| Vegetable | Alho | Garlic | 4.7083 | 2.9310 | 5.4643 |
| Vegetable | Batata | Potato | 3.3333 | 2.8966 | 5.3571 |
| Vegetable | Beringela | Eggplant | 2.6667 | 3.0000 | 5.2500 |
| Vegetable | Beterraba | Beetroot | 2.5833 | 3.0690 | 5.3214 |
| Vegetable | Brócolos | Broccoli | 1.0417 | 3.0690 | 5.1071 |
| Vegetable | Cebola | Onion | 4.1250 | 2.8966 | 4.8571 |
| Vegetable | Cenoura | Carrot | 1.2500 | 3.1724 | 4.8571 |
| Vegetable | Cogumelo | Mushroom | 4.8750 | 3.0690 | 4.5000 |
| Vegetable | Courgete | Zucchini | 2.3182 | 3.0000 | 5.4286 |
| Vegetable | Couve | Cabbage | 1.3333 | 3.0345 | 5.1071 |
| Vegetable | Couve de bruxelas | Brussel Sprouts | 1.4167 | 2.9655 | 5.1429 |
| Vegetable | Couve-flor | Cauliflower | 1.4167 | 2.9655 | 5.1071 |
| Vegetable | Ervilhas | Peas | 1.7917 | 3.0000 | 5.1429 |
| Vegetable | Espargos | Asparagus | 2.3333 | 3.0690 | 5.3214 |
| Vegetable | Espinafre | Spinach | 1.3750 | 3.0345 | 5.1071 |
| Vegetable | Feijão | Bean | 3.2500 | 3.0000 | 5.3929 |
| Vegetable | Grão | Chickpeas | 3.6250 | 2.8621 | 5.6429 |
| Vegetable | Milho | Corn | 3.9167 | 3.0690 | 5.2857 |
| Vegetable | Nabo | Turnip | 2.4583 | 3.0000 | 5.3571 |
| Vegetable | Pepino | Cucumber | 2.1250 | 3.0000 | 5.3571 |
| Vegetable | Rabanete | Radish | 2.4583 | 2.9310 | 5.2143 |
| Vegetable | Salsa | Parsley | 3.8333 | 3.2069 | 5.0357 |
| Vegetable | Tomate | Tomato | 2.6667 | 3.0345 | 5.0357 |
| Weapon | Alavanca | Crowbar | 5.5652 | 3.1379 | 3.2500 |
| Weapon | Bastão | Stick | 2.9583 | 2.4828 | 2.4643 |
| Weapon | Bazuca | Bazooka | 1.4348 | 3.4167 | 3.8333 |
| Weapon | Bomba | Bomb | 1.7917 | 3.9310 | 3.4643 |
| Weapon | Canhão | Cannon | 1.7083 | 3.7241 | 3.3929 |
| Weapon | Chave de fenda | Screwdriver | 5.8333 | 1.7586 | 2.3571 |
| Weapon | Chicote | Whip | 4.7500 | 3.0345 | 2.9286 |
| Weapon | Espada | Sword | 1.5417 | 2.3448 | 2.3571 |
| Weapon | Espingarda | Shotgun | 1.3333 | 3.6897 | 3.3214 |
| Weapon | Faca | Knife | 1.7500 | 1.9310 | 2.1429 |
| Weapon | Fisga | Slingshot | 4.8333 | 3.0345 | 2.5714 |
| Weapon | Gás Lacrimogénio | Tear gass | 3.8333 | 4.0000 | 4.5000 |
| Weapon | Gás Pimenta | Pepper spray | 3.8750 | 4.3793 | 4.4286 |
| Weapon | Granada | Grenade | 1.3750 | 4.4483 | 3.7857 |
| Weapon | Lança | Spear | 2.8333 | 3.0345 | 2.8571 |
| Weapon | Machado | Axe | 3.1250 | 2.0690 | 2.5714 |
| Weapon | Metralhadora | Machine gun | 1.0417 | 4.3103 | 3.5714 |
| Weapon | Míssil | Missile | 1.2500 | 4.2069 | 3.8214 |
| Weapon | Pedra | Stone | 5.5000 | 1.5517 | 1.6071 |
| Weapon | Pistola | Pistol | 1.3750 | 3.8276 | 3.3214 |

*APPENDIX A (continuation)*

| | | | | | |
|---|---|---|---|---|---|
| Weapon | Revólver | Revolver | 1.1250 | 3.7931 | 3.5000 |
| Weapon | Rocha | Rock | 6.2500 | 1.7857 | 1.7500 |
| Weapon | Tanque | Tank | 2.9583 | 3.1724 | 3.2500 |
| Weapon | Veneno | Poison | 3.9167 | 3.7931 | 4.4643 |
| Musical Instrument | Acordeão | Accordion | 1.6667 | 4.0000 | 3.2857 |
| Musical Instrument | Baixo | Bass | 1.3750 | 3.8621 | 3.2857 |
| Musical Instrument | Banjo | Banjo | 2.9048 | 3.7778 | 3.4706 |
| Musical Instrument | Castanholas | Castanets | 3.9167 | 3.2414 | 3.5714 |
| Musical Instrument | Clarinete | Clarinet | 1.7083 | 3.5862 | 3.5357 |
| Musical Instrument | Contrabaixo | Double bass | 1.7083 | 3.8621 | 3.5714 |
| Musical Instrument | Ferrinhos | Triangle | 3.0000 | 3.5862 | 3.4074 |
| Musical Instrument | Flauta | Flute | 1.3333 | 3.6552 | 3.4286 |
| Musical Instrument | Gaita de beiços | Harmonica | 3.0909 | 3.4815 | 3.5769 |
| Musical Instrument | Gaita de foles | Bagpipe | 2.2083 | 3.9655 | 3.2143 |
| Musical Instrument | Guitarra | Guitar | 1.0000 | 3.6897 | 3.0714 |
| Musical Instrument | Harpa | Harp | 1.9583 | 3.7500 | 3.6786 |
| Musical Instrument | Maracas | Maracas | 3.5217 | 3.1481 | 3.2222 |
| Musical Instrument | Órgão | Organ | 1.4167 | 4.0345 | 3.3929 |
| Musical Instrument | Pandeireta | Tambourine | 2.4167 | 3.7931 | 3.4643 |
| Musical Instrument | Piano | Piano | 1.0417 | 3.4138 | 2.9286 |
| Musical Instrument | Saxofone | Saxophone | 1.7083 | 3.6897 | 3.4643 |
| Musical Instrument | Sino | Bell | 4.6667 | 3.7586 | 3.1429 |
| Musical Instrument | Tambor | Drum | 1.5417 | 3.4483 | 3.1429 |
| Musical Instrument | Trombeta | Trumpet | 1.8696 | 3.5926 | 3.1786 |
| Musical Instrument | Trombone | Trombone | 1.6667 | 3.7241 | 3.1786 |
| Musical Instrument | Tuba | Tuba | 2.4167 | 3.3043 | 3.2800 |
| Musical Instrument | Violino | Violin | 1.1250 | 3.7586 | 3.2143 |
| Musical Instrument | Violoncelo | Cello | 1.4583 | 3.8276 | 3.3929 |
| Musical Instrument | Xilofone | Xylophone | 2.1667 | 3.7931 | 3.5000 |
| Kitchent Utensil | Abre-latas | Can opener | 2.2917 | 2.2414 | 2.8929 |
| Kitchent Utensil | Batedor | Whisk | 2.2917 | 2.8276 | 3.2500 |
| Kitchent Utensil | Chaleira | Kettle | 2.4583 | 2.7586 | 2.9630 |
| Kitchent Utensil | Coador | colander | 2.2857 | 1.9615 | 2.6800 |
| Kitchent Utensil | Colher | Spoon | 1.2500 | 1.6552 | 2.1429 |
| Kitchent Utensil | Concha de sopa | Ladle | 1.3750 | 1.5862 | 2.5714 |
| Kitchent Utensil | Copo medidor | Measuring cup | 2.5000 | 1.6552 | 2.7143 |
| Kitchent Utensil | Cortador de Pizza | Pizza cutter | 2.5417 | 2.4828 | 3.0000 |
| Kitchent Utensil | Couvet para gelo | Icecube tray | 3.5417 | 2.0345 | 3.0370 |
| Kitchent Utensil | Descascador de batata | Potato peeler | 2.2500 | 2.4138 | 3.2143 |
| Kitchent Utensil | Espátula | Spatula | 2.0417 | 1.7586 | 2.4286 |
| Kitchent Utensil | Espeto | Skewer | 4.0435 | 2.2759 | 3.0000 |
| Kitchent Utensil | Espremedor de batatas | Potato masher | 3.4091 | 2.9310 | 3.3462 |
| Kitchent Utensil | Espremedor de citrinos | Lemon squeezer | 3.0870 | 2.8621 | 2.8929 |
| Kitchent Utensil | Faca | Knife | 1.0417 | 2.0000 | 2.3571 |
| Kitchent Utensil | Frigideira | Frying pan | 1.1667 | 2.1724 | 2.2857 |
| Kitchent Utensil | Funil | Funnel | 2.9167 | 1.7931 | 2.6786 |
| Kitchent Utensil | Garfo | Fork | 1.2083 | 1.7586 | 2.1429 |
| Kitchent Utensil | Moedor de pimenta | Pepper grinder | 3.6250 | 2.7241 | 3.1071 |
| Kitchent Utensil | Pegas | Oven mitts | 1.7500 | 2.0000 | 3.0000 |
| Kitchent Utensil | Peneira | Flour sifter | 3.3043 | 2.5238 | 3.2000 |
| Kitchent Utensil | Pinça de salada | Tongs | 2.2500 | 1.9655 | 2.6786 |
| Kitchent Utensil | Pincel de cozinha | Basting brush | 3.2500 | 1.8621 | 2.9286 |
| Kitchent Utensil | Prato | Plate | 1.3333 | 1.3793 | 2.0000 |
| Kitchent Utensil | Ralador de Queijo | Cheese grater | 2.5417 | 2.1034 | 3.1429 |
| Kitchent Utensil | Rolo da massa | Rolling pin | 2.0000 | 1.7241 | 2.4286 |
| Kitchent Utensil | Saca-rolhas | Cork screw | 2.2083 | 2.3103 | 2.8214 |
| Kitchent Utensil | Tábua (para cortar) | Cutting board | 2.1667 | 1.4138 | 2.3929 |
| Kitchent Utensil | Tacho | Pot | 1.1250 | 2.0345 | 2.2857 |
| Kitchent Utensil | Tarteira | Pie pan | 2.9000 | 2.2500 | 2.7778 |
| Kitchent Utensil | Temporizador | Timer | 4.0417 | 3.4483 | 3.5000 |
| Kitchent Utensil | Termômetro de carne | Meat Thermometer | 4.3750 | 3.2222 | 3.2800 |
| Kitchent Utensil | Tesoura | Scissors | 3.9167 | 2.2414 | 2.1429 |
| Kitchent Utensil | Tigela | Mixing bowl | 1.6250 | 1.7931 | 2.2857 |
| Kitchent Utensil | Vassoura | Broom | 5.1667 | 1.8966 | 2.0357 |
| Vehicles | Ambulância | Ambulance | 2.3750 | 5.3448 | 3.1786 |
| Vehicles | Autocarro | Bus | 1.2917 | 5.0345 | 2.7500 |
| Vehicles | Avião | Airplane | 2.0417 | 4.9655 | 2.9643 |
| Vehicles | Bicicleta | Bicycle | 2.5417 | 4.4483 | 2.5714 |
| Vehicles | Cadeira de rodas | Wheelchair | 5.5000 | 4.0345 | 3.1071 |
| Vehicles | Camião | Truck | 1.2917 | 4.9655 | 2.9643 |
| Vehicles | Canoa | Canoe | 5.2500 | 3.8621 | 2.7857 |
| Vehicles | Carrinha | Van | 1.3750 | 5.0345 | 3.0000 |
| Vehicles | Carro | Car | 1.0000 | 5.1724 | 2.4286 |

*APPENDIX A (continuation)*

| | | | | | |
|---|---|---|---|---|---|
| Vehicles | Carroça | Wagon | 3.7500 | 4.8276 | 3.1429 |
| Vehicles | Cavalo | Horse | 5.2083 | 5.7586 | 6.1071 |
| Vehicles | Comboio | Train | 1.8750 | 4.8276 | 3.0000 |
| Vehicles | Eléctrico | Street car/trolley | 2.2917 | 5.0000 | 3.4643 |
| Vehicles | Elevador | Lift | 6.2500 | 5.0690 | 3.1786 |
| Vehicles | Esquis | Skis | 5.9167 | 3.3793 | 2.7500 |
| Vehicles | Foguetão | Rocket | 4.9167 | 5.0345 | 3.3929 |
| Vehicles | Helicóptero | Helicopter | 2.3333 | 5.0345 | 3.2857 |
| Vehicles | Iate | Yatch | 3.5833 | 4.7586 | 3.3214 |
| Vehicles | Jangada | Raft | 5.3333 | 3.6207 | 3.2143 |
| Vehicles | Jipe | Jeep | 1.1667 | 4.9655 | 3.0000 |
| Vehicles | Metro | Subway | 2.2500 | 5.2414 | 3.2143 |
| Vehicles | Motocicleta | Motorcycle | 1.5833 | 5.0000 | 3.1071 |
| Vehicles | Navio | Ship | 2.9167 | 4.7586 | 2.9643 |
| Vehicles | Submarino | Submarine | 4.3333 | 5.0000 | 3.1071 |
| Vehicles | Táxi | Taxi | 1.3333 | 5.3448 | 3.3929 |
| Vehicles | Tractor | Tractor | 2.6667 | 4.7241 | 3.1429 |
| Vehicles | Trenó | Sled | 5.6250 | 4.6207 | 3.0714 |
| Vehicles | Triciclo | Tricycle | 3.7917 | 4.2759 | 3.0714 |
| Vehicles | Trotinete | Scooter | 4.7500 | 4.5357 | 2.9643 |
| Clothing | Avental | Apron | 5.5417 | 2.3448 | 2.6786 |
| Clothing | Blusa | Blouse | 1.3333 | 2.2759 | 2.6786 |
| Clothing | Bolsa | Purse | 5.5833 | 2.1379 | 2.7857 |
| Clothing | Boné | Cap | 4.0833 | 2.2069 | 2.5357 |
| Clothing | Botas | Boots | 3.3333 | 2.2759 | 2.3929 |
| Clothing | Cachecol | Scarf | 3.5833 | 2.2414 | 2.5714 |
| Clothing | Calças | Pants | 1.0417 | 2.2414 | 2.6429 |
| Clothing | Camisa | Shirt | 1.1667 | 2.5172 | 2.5714 |
| Clothing | Camisola | Sweater | 1.0833 | 2.2759 | 2.3214 |
| Clothing | Capa | Cape | 3.7500 | 2.2759 | 2.6429 |
| Clothing | Casaco | Jacket | 1.0833 | 2.3448 | 2.4286 |
| Clothing | Chinelos | Slipper | 3.9583 | 2.1034 | 2.5000 |
| Clothing | Cinto | Belt | 4.5833 | 2.2414 | 2.3929 |
| Clothing | Colar | Necklace | 6.0833 | 1.9310 | 2.3929 |
| Clothing | Colete | Vest | 2.5000 | 2.3103 | 2.8929 |
| Clothing | Collants | Leotards | 3.1250 | 2.2500 | 2.9643 |
| Clothing | Fato de banho | Swimsuit | 3.5833 | 2.2069 | 2.5714 |
| Clothing | Gravata | Tie | 3.7917 | 2.2759 | 2.5000 |
| Clothing | Luvas | Mittens | 3.8333 | 1.9655 | 2.4643 |
| Clothing | Manto | Cloak | 4.8261 | 2.2759 | 3.1481 |
| Clothing | Meias | Socks | 2.4167 | 2.4828 | 2.5357 |
| Clothing | Pijama | Pajama | 2.6667 | 2.3103 | 2.8929 |
| Clothing | Relógio | Wristwatch | 6.0000 | 3.7931 | 2.2857 |
| Clothing | Roupão | Robe | 3.4583 | 2.0690 | 2.7143 |
| Clothing | Saia | Skirt | 1.2500 | 2.3793 | 2.7500 |
| Clothing | Sapato | Shoe | 3.2500 | 2.6897 | 2.2143 |
| Clothing | Sobretudo | Coat | 2.1250 | 2.2759 | 3.1786 |
| Clothing | Soutien | Bra | 2.4583 | 2.3448 | 2.9643 |
| Clothing | Vestido | Dress | 1.2500 | 2.3448 | 2.3929 |
| Clothing | Xaile | Shawl | 4.5000 | 2.1724 | 3.0357 |
| Birds | Abutre | Vulture | 2.4583 | 2.9655 | 1.7143 |
| Birds | Águia | Eagle | 1.0833 | 2.2759 | 1.5357 |
| Birds | Avestruz | Ostrich | 3.1667 | 2.5517 | 1.7143 |
| Birds | Canário | Canary | 1.6250 | 2.1379 | 1.8214 |
| Birds | Cegonha | Stork | 1.7083 | 2.5862 | 1.5714 |
| Birds | Cisne | Swan | 2.2917 | 2.4483 | 1.6071 |
| Birds | Coruja | Owl | 1.7500 | 2.6207 | 1.4643 |
| Birds | Corvo | Raven | 1.8333 | 2.8621 | 1.7500 |
| Birds | Faisão | Pheasant | 2.2917 | 2.4583 | 2.0370 |
| Birds | Falcão | Falcon | 1.2500 | 2.4138 | 1.7857 |
| Birds | Flamingo | Flamingo | 2.6250 | 2.6207 | 1.8214 |
| Birds | Gaivota | Seagull | 1.2917 | 2.4828 | 1.5714 |
| Birds | Galinha | Chicken | 2.0417 | 2.4828 | 1.3571 |
| Birds | Galo | Rooster | 2.1250 | 2.4828 | 1.4643 |
| Birds | Ganso | Goose | 2.6250 | 2.5862 | 1.8929 |
| Birds | Melro | Blackbird | 1.8333 | 2.6071 | 1.8571 |
| Birds | Mocho | Owl | 1.8333 | 2.6207 | 1.5357 |
| Birds | Pardal | Sparrow | 1.6250 | 2.3103 | 1.8571 |
| Birds | Pato | Duck | 2.5833 | 2.2069 | 1.4643 |
| Birds | Pavão | Peacock | 2.2500 | 2.6897 | 1.7143 |
| Birds | Pelicano | Pelican | 2.8333 | 2.5862 | 2.0000 |
| Birds | Perdiz | Partridge | 1.8333 | 2.5862 | 1.9643 |
| Birds | Periquito | Parakeet | 1.7083 | 2.0714 | 1.6786 |

*APPENDIX A (continuation)*

| | | | | | |
|---|---|---|---|---|---|
| Birds | Peru | Turkey | 2.5833 | 2.6552 | 1.9286 |
| Birds | Pica-Pau | Woodpecker | 2.0833 | 2.1034 | 1.8214 |
| Birds | Pinguim | Penguin | 4.2083 | 2.4483 | 1.4286 |
| Birds | Pomba | Dove | 1.6250 | 2.4483 | 1.7857 |
| Birds | Pombo | Pigeon | 1.7500 | 2.2414 | 1.5357 |
| Birds | Rouxinol | Nightingale | 1.6250 | 2.4483 | 2.0000 |
| Insects | Ácaro | Mites | 5.2381 | 4.1429 | 4.3214 |
| Insects | Aranha | Spider | 2.2917 | 2.8966 | 1.7500 |
| Insects | Barata | Cockroach | 1.6250 | 2.8966 | 2.5000 |
| Insects | Besouro | Beetle | 1.7826 | 2.9643 | 2.5000 |
| Insects | Borboleta | Butterfly | 3.0417 | 2.3103 | 1.5357 |
| Insects | Carraça | Tick | 4.2083 | 3.4138 | 3.2500 |
| Insects | Centopéia | Centipede | 2.8333 | 3.0000 | 2.5357 |
| Insects | Cigarra | Cicada | 2.2500 | 3.0345 | 2.4643 |
| Insects | Formiga | Ant | 1.8750 | 2.6207 | 1.8571 |
| Insects | Gafanhoto | Grasshopper | 1.7500 | 2.6552 | 2.0357 |
| Insects | Grilo | Cricket | 1.7917 | 2.4828 | 2.2857 |
| Insects | Joaninha | Ladybug | 1.7083 | 2.6897 | 2.0714 |
| Insects | Lagarta | Caterpillar | 4.0833 | 3.0345 | 2.2857 |
| Insects | Libélula | Dragonfly | 3.0870 | 2.6071 | 2.6538 |
| Insects | Louva-a-Deus | Praying mantis | 2.0417 | 3.0741 | 2.5357 |
| Insects | Minhoca | Worm | 4.0833 | 3.1034 | 2.2143 |
| Insects | Mosca | Fly | 1.2083 | 2.1034 | 2.1786 |
| Insects | Mosquito | Mosquito | 1.2500 | 2.4138 | 2.3214 |
| Insects | Piolho | Lice | 4.4583 | 3.2759 | 3.0357 |
| Insects | Pulga | Flea | 3.6667 | 3.1034 | 3.0000 |
| Insects | Traça | Moth | 2.7083 | 3.1724 | 3.1071 |
| Insects | Vespa | Wasp | 1.5833 | 2.3793 | 2.1786 |
| Mammals | Alce | Moose | 2.9583 | 2.6800 | 1.8214 |
| Mammals | Baleia | Whale | 2.6667 | 2.5517 | 1.3214 |
| Mammals | Bode | Billy goat | 2.4167 | 2.7586 | 1.8929 |
| Mammals | Búfalo | Buffalo | 2.3333 | 2.7931 | 1.7857 |
| Mammals | Burro | Donkey | 1.4583 | 2.6552 | 1.2857 |
| Mammals | Camelo | Camel | 2.5417 | 2.6552 | 1.6071 |
| Mammals | Cão | Dog | 1.2500 | 1.9310 | 1.0000 |
| Mammals | Castor | Beaver | 3.2500 | 2.4138 | 1.7500 |
| Mammals | Cavalo | Horse | 1.6250 | 2.2414 | 1.1429 |
| Mammals | Chimpanzé | Chimp | 1.3333 | 1.9655 | 1.4286 |
| Mammals | Coelho | Rabbit | 2.0417 | 2.1379 | 1.2500 |
| Mammals | Elefante | Elephant | 1.7083 | 2.5517 | 1.3929 |
| Mammals | Esquilo | Squirrel | 3.1667 | 2.4138 | 1.6786 |
| Mammals | Foca | Seal | 3.0833 | 2.4138 | 1.6429 |
| Mammals | Gato | Cat | 1.2500 | 2.2414 | 1.0357 |
| Mammals | Girafa | Giraffe | 1.8750 | 2.3103 | 1.2857 |
| Mammals | Golfinho | Dolphin | 1.8333 | 2.0345 | 1.1786 |
| Mammals | Gorila | Gorilla | 1.4583 | 2.2069 | 1.4286 |
| Mammals | Hiena | Hyena | 2.4583 | 2.4828 | 1.6071 |
| Mammals | Leão | Lion | 1.3750 | 2.4828 | 1.1071 |
| Mammals | Leopardo | Leopard | 2.1667 | 2.4138 | 1.3929 |
| Mammals | Lontra | Otter | 3.2500 | 2.6207 | 1.8929 |
| Mammals | Morcego | Bat | 4.0417 | 2.6897 | 1.5357 |
| Mammals | Ovelha | Sheep | 1.6250 | 2.5862 | 1.4643 |
| Mammals | Porco | Pig | 1.6667 | 2.4483 | 1.2500 |
| Mammals | Porco-espinho | Porcupine | 4.1250 | 2.6207 | 2.0000 |
| Mammals | Puma | Cougar | 2.3913 | 2.6786 | 2.3929 |
| Mammals | Raposa | Fox | 1.8750 | 2.5862 | 1.3214 |
| Mammals | Rato | Mouse | 2.9167 | 2.2414 | 1.5000 |
| Mammals | Touro | Bull | 2.1250 | 2.5862 | 1.4643 |
| Mammals | Urso | Bear | 1.6667 | 2.4483 | 1.3214 |
| Mammals | Vaca | Cow | 1.7083 | 2.6552 | 1.1786 |
| Mammals | Veado | Deer | 2.5417 | 2.5517 | 1.5714 |
| Mammals | Zebra | Zebra | 1.7917 | 2.4828 | 1.3571 |