

Honoring Different Ontological Boundaries: The Role of Language in Category Formation

Duc N. Tran (dntran2@uh.edu)

Department of Psychology, 126 Heyne Bldg.
Houston, TX 77204 USA

Hanako Yoshida (yoshida@uh.edu)

Department of Psychology, 126 Heyne Bldg.
Houston, TX 77204 USA

Abstract

The present study examines the different ways in which language structure marks individuation and cue early attention in a novel noun generalization task. Results in the present study extend the Boundary Shift Hypothesis, suggesting that the linguistic boundary between individuals and nonindividuals influences the perceptual boundaries and the correlational patterns formed overtime between ontological kinds. The results provide a new perspective on the facilitative role of linguistic markers in category formations, rather than strictly in boundary formations. This demonstrates the potential degree of cognitive processing among different language learners and lends support towards a mechanistic explanation of the role of language in categorical formations.

Keywords: category learning, categorical structure, ontology, ontological boundaries, linguistic structure, individuation

Introduction

Language is a symbol system that maps the world's categories. It allows people to efficiently shape their world through abstract representations. Words have long been viewed as a vital unit that allows one to shape abstract information to promote and refine clusters of information for representational use. Such examinations allow one to group information into arbitrary categories that assist in later retrieval (with less effort and less cost). Categories are essential in all general learning and have become a key device in allowing children (Katz, 1963) and adults (Goldstone, Lippa, & Shiffrin, 2001) to effectively make sense of their surrounding world. Previous research concerning ontological boundaries provided evidence that suggests linguistic cues available in one's environment enhances the way world categories are distinctively perceived. The present mechanistic proposal hypothesizes that if a language supports both boundaries, then the cluster of correlations between perceptual and linguistic cues available in such language should readily aid in honoring all ontological categories. The present research addresses this question by examining how the Vietnamese language may honor different ontological boundaries and, more importantly, category formation.

Categorical Structure and Ontological Distinctions

There are three different types of ontological categories in the world: Animate, Inanimate (Discrete), and Substances.

Distinctions between these categories depend on the magnitude of individuation. In the Individuation Continuum described by Lucy (1992), individuation occurs when an entity is conceptualized as bounded and discrete. In this continuum, animates lie at one end (more individualized) and substances at the other end (less individualized) of a continuous spectrum, with inanimates comprising the middle (i.e., animates——inanimates——substances). The likelihood that a particular entity is conceptualized as an individual varies systematically across the continuum from animates to substances (Lucy, 1992).

Learning associations for categorization that ties labels and meanings together facilitates relational judgments to be transferred to novel stimuli (Lupyan, Rakison & McClelland, 2007). For instance, when different labels were provided among the same exemplars, discrete differences are highlighted between the stimuli that affect one's judgment to separate items into different categories (Lupyan, Rakison & McClelland, 2007). A traditional approach to this issue has asked whether language is simply a symbol system that maps to all the relevant categories found in the world. Another view is that language creates and shapes human cognition (Whorf, 1956). People can interpret the world quite differently if they come from different language backgrounds and such differences have significant effects on the level of cognitive processing among these language learners (Cook, 1977; Bent, 2006). Research on the Japanese and English language, for instance, posits the importance of linguistic cues as a vital factor that couples available perceptual cues in the environment to facilitate perceptual regularities in the world (Imai & Gentner, 1997; Yoshida & Smith, 2005).

Individuation in English In English, individuation is frequently demonstrated by the count/mass distinction. Count nouns are nouns that can take the plural form (e.g. cups, cats), usually denoted with an *-s* after the noun. Thus, count nouns are conceptualized as discrete entities that are bounded and individualized. Mass nouns, however, are not pluralized (e.g., milk, water), but instead take continuous quantifiers (e.g., some, much). Thus, mass nouns are conceptualized as continuous entities that are unbounded and massed. For example, "*My cats (count noun) drank some (continuous quantifier) milk (mass noun) from the*

bowl” would be more grammatically correct than “*My many cat drank milks from the bowl.*” Although nouns may take both count and mass forms (e.g., “*Would you like some muffins?*”), English generally treats animates and objects as individuals, while substances are treated as masses. The likelihood of treating an object as an individual, therefore, drops markedly between objects and substances in English (Soja, Carey & Spelke, 1991; Soja, 1992; Imai & Gentner, 1997; Yoshida & Smith, 2003). See Figure 1 for an illustration. Further, solidity proves to be an important factor that highlights the contrastive nature between substances among other objects (Colunga & Smith, 2000). The key point here is that the English language privileges substances as continuous masses.

	Japanese		Vietnamese		English	
Linguistic Individuation	Individuals				Masses	
Conceptual Distinction	Animate		Objects		Substances	
Perceptual Cues	Multiple similarities People dog shell		Shape doll car cup		Materials chunk of wood foam milk	

Figure 1: Three mutually dependent layers: linguistic, conceptual, and perceptual organization of the Boundary Shift Hypothesis. Linguistic individuation marks descriptive linguistic functions (e.g., lexical semantics/animacy, classifiers) available in each language—that is, *-iru* and *-aru* Japanese distinctions for animates; *mass/count* English distinctions for substances. Conceptual distinctions indicates the ontological categories—animates, inanimates/objects, and substances. Perceptual cues indicate the typical features associated with each ontological category provided in the real world. Different ontological distinctions for each language (Japanese and English; Yoshida & Smith, 2003) and the predicted boundaries for Vietnamese are illustrated.

Individuation in Japanese Japanese lexical and syntactic devices relevant to individuation are different from those in English (Yoshida, 2001). Japanese nouns that refer to multiple entities are not necessarily pluralized (e.g., the same expression can mean the same thing—“*there was a dog*” and “*there were many dogs*”). A particular plural suffix *-tachi* is never used with inanimate nouns (and is optional with animate nouns). There are unique quantifiers for animates, but those used for objects and substances form an overlapping set. The Japanese language also have separate ‘exists/is located’ verbs for animates and inanimates (*-iru* and *-aru* respectively). Thus, the likelihood of treating an object as an individual drops markedly between animates and objects in Japanese. See Figure 1. The key point here is that the Japanese language privileges animates as individuals (Yoshida & Smith, 2003).

In both cases, this can be considered as the consequence of different correlational patterns among the types of linguistic cues available in each language. Recent studies have taken such measure by providing a mechanistic approach in exploring the role of language in category

formations through the Boundary Shift Hypothesis (e.g., Yoshida & Smith, 2003, 2005; Hidaka & Saiki, 2004).

The Boundary Shift Hypothesis

A mechanistic approach towards the formation of categorical organizations could, perhaps, be explained by the Boundary Shift Hypothesis (Yoshida & Smith, 2003). As introduced by Yoshida & Smith (2003), “ontological partitions” individuates the boundaries through specification of categorical concepts among the three distinct psychological forms (i.e., different kinds of existence) that serve as a foundation for human category learning (i.e., animals/animates, object/inanimates, and substance). Each category has its own set of perceived characteristics and children are able to categorize novel objects based upon its perceptual traits (Landau, Smith & Jones, 1988). Based on previous studies, it has been suggested that when children are presented with an object with eyes and/or limbs and a novel name, they are likely to select different objects that have the same shape and texture, thereby strengthening a category based on animate features (Yoshida & Smith, 2003). However, children are likely to form categories based on the same shape when objects are solid, angular, and made-up of multiple parts (Yoshida & Smith, 2003). The Boundary Shift Hypothesis explains ontological partitions by advocating the view that the language one learns influences or shifts the boundaries of the ontological space of objects and substances (Yoshida & Smith, 2003). Namely, this view suggests that categorization may be due to the correlational structure presented in the world (Samuelson & Smith, 1999). The cluster of correlations between perceptual and linguistic cues relevant to individuation enhances the perceptual characteristics of individualized entities and support formation of ontological categories (Yoshida & Smith, 2003). See Figure 2 and 3 for an illustration. Correlations among these perceptual cues and category structure, then, are systematically generalized by each language and differ accordingly among different language systems (i.e., consequences of different correlational patterns).

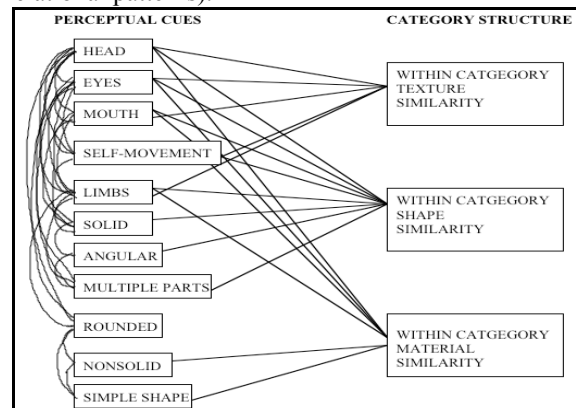


Figure 2: Illustration of associations between perceptual cues and category structure available in the world (Yoshida & Smith, 2003).

In this sense, language is viewed as a functional aspect that encompasses clusters of associations (i.e., weight of the correlations) that modifies the way we conceptualize categories. As demonstrated by Imai & Gentner (1993) and Yoshida & Smith (2003), psychological forms are conceptualized differently in English and Japanese. Thus, ontological categories are the products of learned correlations among the perceptual and linguistic cues.

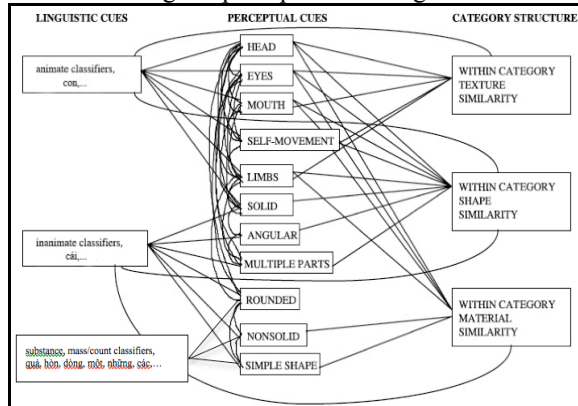


Figure 3: Associations among perceptual cues, category structure and linguistic cues available to learners of Vietnamese.

As a simple mapping system, language would honor the existing category structure and not influence category development. Thus, category development would be similar between children speaking different languages. The big question is, if language structure plays a vital role in shifting the boundaries between different ontological categories, would a language that have clear distinctions in representing different ontological structures demonstrate clear ontological partition (thus supporting the Boundary Shift Hypothesis)? All such theories predict that boundaries are formed from clusters of correlations; however, categorical knowledge is vast and may require more sophisticated ideas in explaining multiple categories. The purpose of the present study examines whether this type of boundary shifting (i.e., creating one boundary) is necessary for all children, or if children can reflect the reality of the three distinct categories. That is, the study explores the different ways in which language structure marks individuation by examining the Vietnamese language, which has implications in category formation through utilization of explicit classifiers to represent different ontological categories. If language does indeed influence category structure, we would expect to find a difference between the category formations of young children speaking different languages.

Vietnamese Classifiers

Why Vietnamese? Vietnamese is a rich language that encompasses multitudes of explicit classifiers for speakers to conceptualize, classify, and describe spatial characteristics (shape, size, position) of objects in the surrounding world (Ly, 1999). Vietnamese classifiers are groups of nouns that have grammatical/syntax (Nguyen,

1963, 1975), semantic (Ly, 1999), and some implications in cognitive foundations (Lakoff, 1986; Friedrich, 1970). In the Vietnamese language, there are more than 40 different types of classifiers.

Vietnamese classifiers have two main functions: (1) singling out objects from different classes and, (2) help partition the world categories into various types (Ly, 1999). For example, in the sentence “con mèo” or “a cat” (CL+cat), the cat here is perceived as an individual animate object because of the classifier, whereas “cái ghế” or “a chair” (CL+chair) will be used to denote an individual inanimate object. In the Vietnamese language, the classifier “cái” is used most often for inanimate objects, while the classifier “con” indicates general animacy. Furthermore, classifiers describe explicitly the spatial characteristics of objects through the notion of salience and meaning. For instance, in English, the spherical feature is included in the meaning of the noun “ball” only implicitly. In Vietnamese, the same feature receives explicit expression by means of the classifier “quả/trái” (fruit/round-like), such as “quả/trái banh” or “a ball” (CL+ball).

Moreover, there are two types of classifiers: (1) Numerical (or non-descriptive) and (2) Descriptive. In numerical classifiers, an example would be “cái ghế” or “a chair” (CL+chair), which demonstrates that the classifier “cái” is indicating one chair. “Con”, however, may be used to describe inanimate and/or substances that are volitional in nature, such as “con sông” or “a river” (CL + river); “con dao” or “a knife” (CL + knife). When paired up with numerals, both classifiers may indicate count nouns. Without the use of “cái”/“con” preceding the noun, mass nouns would be implicated.

Additionally, there are certain distinctions for mass/count nouns in the Vietnamese language. For count nouns, singular forms are determined whether there is definite/limited size (e.g., “một cái bánh” or “a (one) piece of cake” numeral+CL+noun) or indefinite in size through the deletion of numerals (e.g., “cái bánh” or “piece of cake”; CL+noun). In a similar vein, plural count nouns are also dependent on definite/limited in size (e.g., “những cái bánh” or “some cake”; limited plural+CL+noun) and indefinite/maximal in size (e.g., “các cái bánh” or “every/all cake”; unlimited plural+CL+noun)—both of which can be viewed in parallel to the -s suffix that is added at the end of nouns in the English language. For mass or non-count nouns, however, it is not dependent on the size. Cao (1999) notes that mass nouns in Vietnamese are neutral to definiteness or non-definiteness. Where, in contrast, the zero article is used with a non-count noun (e.g., “bánh” or “cake” (zero or no CL+noun).

Given the richness of the descriptive language structure in Vietnamese, where would the Vietnamese language stand in regards to the Boundary Shift Hypothesis? That is, the linguistic boundary between individuals and nonindividuals perceptual boundaries between ontological kinds. Further, how do children come to understand the type of items or objects that are organized in different ways? Where does the

knowledge of different kinds of things emerge (i.e., animates, inanimates/objects, substances)? Japanese and English demonstrate homogenous differences in honoring two different ontological boundaries, is one or the other maximized or are both ontological distinctions present in the Vietnamese language? The present study hypothesizes that Vietnamese children should behave similarly to Japanese and English children—that is, the richness of the Vietnamese language should allow children to build distinct categorical formations for all ontological boundaries. See Figure 1. To test children’s knowledge of ontological categories, an adaptation of the Novel Noun Generalization (NNG) task was used (Soja, 1992). NNG tasks have been used to provide insight into children’s systematic expectations about how nouns map to distinct categories.

Method

Participants

Thirty monolingual Vietnamese participants with ages ranging from 23.85 to 33.22 months ($M=29.59$, $SD=2.91$) from Vietnam participated in the present study. Of the 30 participants, 20 completed the entire task and were therefore included in the analysis (attrition rate= 33.33%; 7 due to fussiness, 3 due to fatigue). Participants were recruited at a local preschool in Đồng Nai, Việt Nam. Prior to participation, all children were screened to ensure that Vietnamese was the only language they were regularly exposed to.

Control. Nine monolingual Japanese participants with ages ranging from 23.71 to 40.39 months ($M=31.72$, $SD=5.78$) from the USA (recently immigrated; temporary residents) participated in the present study for comparison results. Of the 9 participants, 8 participants completed the entire task (1 due to fussiness). Participants were recruited at a local Japanese daycare in Houston, TX. Primary caretakers were monolingual Japanese. Prior to participation, all children were screened on English and Japanese to ensure that Japanese was the only language they were regularly exposed to.

Measurement Tools

A basic demographic questionnaire on language exposure and a parent checklist on productive vocabulary were used to ensure and control for homogeneity among the participants. To assess the children’s vocabulary, parents were asked to complete an adapted Vietnamese version of the MacArthur–Bates Communicative Development Inventories (MCDI; Fenson, Dale, Reznick, Bates, Hartung, Pethick, & Reilly, 1993). The Vietnamese version of the MCDI was developed by translating the American English (Fenson et al., 1993) and the Japanese MCDI (Ogura & Watamaki, 1997; see also Ogura, Yamashita, Murase, & Dale, 1993). Adult native speakers of Vietnamese translated and modified the documents. For the control group, the Japanese MCDI was used. The MCDI was used to control for vocabulary development among the participants.

Procedure

Children sat at a comfortable distance from the computer screen in a quiet room at the preschool. A native Vietnamese experimenter sat next to the child and administered the task. A 5-minute break was implemented after the 27th trial (of 54 total trials) to reduce fatigue. Responses were recorded in-session by the experimenter.

Task

The task was administered as a flash demonstration on a 15” HP laptop. There were a total of 54 trials consisting of 18 exemplars—6 animates, 6 inanimates, 6 substances—with 3 presentations each exemplar. Trials were presented in 6 blocks (i.e., 9 trials per block).

Familiarization trials. Children were presented with flash demonstrations of novel entities that were animate, inanimate, and substance. The objects were mixed and orders were randomized. All flash demonstrations began with the appearance of a novel object, followed by an animation of a hand acting upon the object.

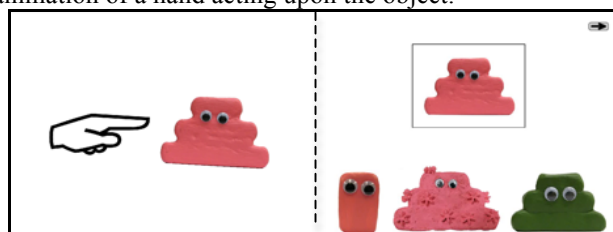


Figure 4: Animate. Testing choices matched on Color+Texture (CO+TX), Shape+Color (SH+CO), and Shape+Texture (SH+TX) from left-to-right respectively.



Figure 5: Inanimate. Testing choices matched on SH, TX, and CO from left-to-right respectively.

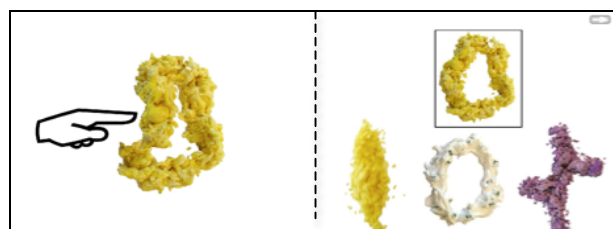


Figure 6: Substance. Testing choices matched on CO, SH, and TX from left-to-right respectively.

For animates, the novel entity had animate characteristics such as blinking eyes and volitional mannerisms (i.e., moved out of the screen from the incoming hand). For inanimates, novel objects were depicted without animate

cues (i.e., angular, curvature, solid blocks) and demonstrated static mannerisms (i.e., incoming hand moved the object out of the screen). For substances, the non-solidity feature was illustrated by manipulations from the hand (i.e., incoming hand changed the shape of the substance). See Figure 4-6 for an example of the animate, inanimate, and substance stimuli used. During each flash demonstration, the experimenter would introduce a new novel label attached to each entity (e.g., “*Này là Phoom. Em thấy không? Đây là Phoom đó!*”/“*This is a Foom (novel label). See? This is a Foom (novel label)!*”). Instructions were given in a neutral manner (i.e., no classifiers were given) to avoid biasing the child’s response.

Testing trials. After each demonstration, children were shown three testing choices and were asked to identify which of the new testing choices presented is called by the same label (e.g., “*Em chỉ cho chị, nào là Phoom?*”/“*Can you point to the Foom (novel label)?*”). Again, questions were given in a neutral manner to avoid biasing the child’s response. For animates, testing choices were matched on Shape-Texture (SH+TX), Shape-Color (SH+CO), and Color-Texture (CO+TX). For inanimates and substances, testing choices were matched on Shape (SH), Texture (TX), and Color (CO). See Figure 4-6 for an example of the testing choices. According to Jones & Smith (2002), adult judgment indicates that the expected answer choice for animates should be organized by similarities based on SH+TX, SH for inanimates, and TX for substances.

Results

Replicating previous results (Imai & Gentner, 1997; Yoshida & Smith, 2001, 2003), Japanese monolingual participants (control group) significantly chose feature matched on SH+TX ($t(7)=2.986, p<.05$) for animates, SH ($t(7)=1.225, p<.05$) for inanimates, and SH ($t(7)=3.666, p<.05$) for substances.

As predicted for the Vietnamese participants, results demonstrate that they honored all ontological distinctions—animates, inanimates, and substances—suggesting the role of language in category structure.

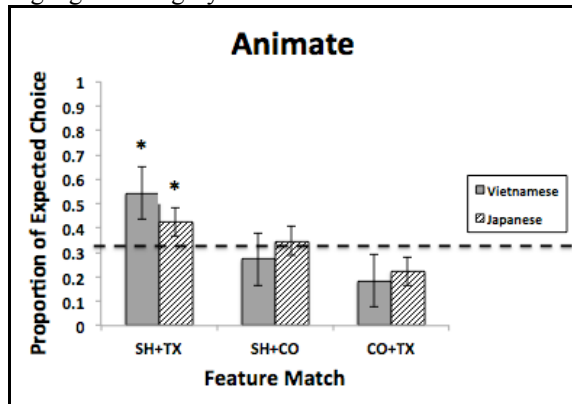


Figure 7: Proportion of expected choice for Animates matched on SH+TX, SH+CO, and CO+TX.

That is, Vietnamese participants significantly chose feature matched on SH+TX for animates, SH for inanimates, and TX for substances. Proportion of expected choices were performed against chance ($p=.33$) using multiple t-tests. All expected choices were significantly above chance as illustrated by the star and dotted line (See Figure 7-9).

Specifically, in the *animate trials*, Vietnamese participants chose feature matched on SH+TX (expected) 53.89% of the time, $t(19)=4.597, p<.001$, versus 28.61% for SH+CO match, $t(19)=-.913, p=.373$, and 17.5% for CO+TX match, $t(19)=-5.220, p<.001$. See Figure 7.

For the *inanimate trials*, Vietnamese participants chose feature matched on SH (expected) 56.38% of the time, $t(19)=4.514, p<.001$, versus 20% for TX match, $t(19)=-3.739, p<.001$, and 23.61% for CO match, $t(19)=-2.021, p=.058$. See Figure 8.

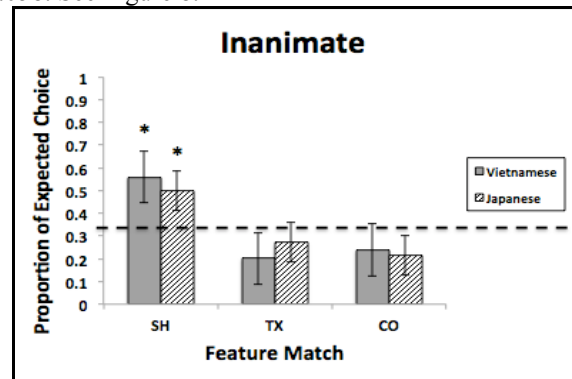


Figure 8: Proportion of expected choice for Inanimates matched on SH, TX, and CO.

Finally, in the *substance trials*, Vietnamese participants chose feature matched on TX (expected) 48.89% of the time, $t(19)=3.620, p<.01$, versus 26.67% for SH match, $t(19)=-1.468, p=.158$, and 25% for CO match, $t(19)=-2.010, p=0.59$. See Figure 9.

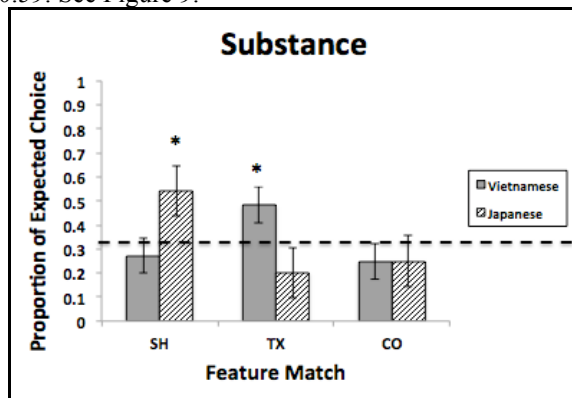


Figure 9: Proportion of expected choice for Substances matched on SH, TX, and CO.

General Discussion

Results from the present study supports previous research (i.e., Boundary Shift Hypothesis) suggesting that the way in which children form categories depends largely on the language they are learning and the correlational patterns

they develop given the perceptual cues and regularities available in their environment. In particular, individuation among the perceptual boundaries between ontological kinds in the Vietnamese language is highly influenced by the availability and use of explicit classifiers within the language. Specifically, classifiers that highlight animates (i.e., *con*), inanimates (i.e., *cái*), and substance (i.e., numerical+CL inclusions for count nouns and deletion of classifiers for mass nouns) among the variety of classifiers help Vietnamese children to identify the discrete differences among different entities. Overtime, such regularities are produced to create clusters of correlations that allow children to form discrete ontological boundaries. This suggests that categorization is highly dependent on the structure of the language being learned, perceptual cues and regularities available in the environment, and the correlational pattern over time. The current results indicate that this phenomena is robust across tasks, regardless of task variations (Soja, Carey & Spelke, 1991; Soja, 1992; Imai & Gentner, 1997; Yoshida & Smith, 2003), among a variety of languages that foster distinct ontological boundaries. Therefore, we expect that English monolingual children should behave similarly from previous literature (Soja, Carey & Spelke, 1991; Yoshida & Smith, 2003). In sum, how children form categories may depend largely on the language they are learning and, in particular, on the way that language individuates kinds.

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