Young Children and Adults Extend Novel Nouns to Objects not Places

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Abstract

Young children's intuitions about the meanings of novel nouns have revealed foundational biases in language learning. Nevertheless, existing work on such word-learning biases has focused primarily on only one spatial domain to which nouns might refer—objects—not the large-scale and navigable places in which objects are situated. Previous research has nevertheless shown that adults and children treat objects and places differently not only in recognition and navigation tasks, but also in symbolic tasks, like drawing production. In a noun-extension task, we thus evaluate young children's and adults' word-learning biases across these two spatial domains—objects and places—and show that young children and adults treat objects and places differently in language: Young children and adults preferentially extend novel nouns to objects over places. This bias suggests a specific role for spatial domain in word learning and may reflect greater attention to objects over places in symbolic contexts like language.

Keywords: word learning; noun extension; spatial domain; objects; places

Introduction

Children demonstrate reliable intuitions when learning the meaning of nouns. One well-known example of such an intuition is the *shape bias* (e.g., Baldwin, 1992; Landau et al., 1988). In Landau et al. (1988), for example, 2- to 3-year-old children were shown a sample object labeled with a novel noun (e.g., "This is a *dax*."). Then, children were shown two new objects and were asked, "Which of these is a *dax*?" The two new objects differed from the sample object in size, texture, or shape. Children were more likely to extend *dax* to one of the new objects that matched the sample in shape as opposed to one that matched it in size or texture, suggesting that children are inclined to extend novel nouns to objects of the same shape. Since this seminal study, researchers have noted other word-learning biases about objects, including children's tendency to extend novel nouns to whole objects as opposed to object parts (e.g., Markman & Wachtel, 1988) and to objects from the same taxonomic category (e.g., Baldwin, 1992; Waxman & Booth, 2001).

Nevertheless, objects are just one domain of spatial information that young children encounter and to which nouns might refer. In particular, objects are situated in *places* with particular spatial layouts, such as open fields, closed cityscapes, and indoor rooms. Foundational geometric information differentiates objects and places. While objects tend to be small, free-standing, and manipulable, places are instead delineated by the fixed geometry of the large-scale extended surface layout and are navigable (Lee et al., 2006).

Previous studies examining children's word-learning biases have either focused almost exclusively on the domain of objects, like the studies described above, or have treated objects and places in an undifferentiated way, not fully accounting for their differing geometry. For example, studies focusing on the language that describes containment-support, path-manner, source-goal, and figure-ground relations often consider an object like *table* in the phrase, "the book is on the table" as referring to a place (e.g., Landau & Jackendoff, 1993; Landau & Stecker, 1990; Talmy, 1978), aligning place information with more general ground information as opposed to aligning it with the table's geometric properties, which are consistent with it being an object. In the present research, we dissociate objects and places from more general figure-ground relations and only consider places as spatial entities with a navigable extended-surface layout. We then ask: What are young children's and adults' word-learning biases when both object and place information could be the referent of a novel noun? Do they preferentially extend the novel noun to the object or the place?

Differential treatment of objects and places has been well documented by neuroimaging and behavioral studies not only focusing on non-symbolic tasks like recognition and navigation (e.g., Dillon et al., 2018; Doeller et al., 2008; Epstein & Kanwisher, 1998; see also Spelke & Lee, 2012, for a review), but also on tasks probing drawing production (e.g., Dillon, 2021; Dillon & Spelke, 2017), which, like language, is symbolic and communicative. For example, in Dillon & Spelke (2017), 4-year-old children were presented with perspectival line drawings that either depicted just a room's place information (i.e., its ceiling, walls, and floor) or just its object information (i.e., its chairs, table, trash bins). In one task, children were asked to use the drawings to find locations in the room that were either close to the room's place information (e.g., in a corner) or its object information (e.g., by a chair). Children were more successful with the place-only drawings when searching for the locations near the room's place information but were more successful with the object-only drawings when searching for the locations near the room's objects. In another task in that study, however, the same children were asked whether the place-only or object-only drawings were more informative about each type of location. For both types, children judged the object-only drawings to be better and more informative. Children may thus prefer to communicate about space through symbolic drawings using object over place information.

Consistent with this finding on children's judgments about drawings, children's own drawing production suggests a similar preference for object over place information. In

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Dillon (2021), for example, 4-year-old children either sat in a colorful fort composed of three rectangular walls and with three rectangular objects inside (the *place* condition) or sat in front of a 3D toy model of the fort (the *object* condition) and were asked to draw exactly what they saw. Children in the place condition drew only the objects, not the walls that composed the fort's layout. Children in the object condition, in contrast, drew the toy parts that corresponded to both the objects and layout of the fort. Children's drawing production thus also shows this object-over-place bias.

In the present study, we examine whether a similar object-over-place bias is present in young children's and adults' expectations in another symbolic and communicative medium: *language*. We do so in two preregistered experiments, testing college-aged adults (**Experiment 1**) and 3- to 4-year-old children (**Experiment 2**) in a noun-extension task modeled after Landau et al. (1988). In each experiment, participants were randomly assigned to one of two conditions. In the *place* condition, participants saw a picture of a rendered indoor scene composed of place and object information each with a distinct shape (e.g., a dome-shaped room with a hexagon-shaped block inside; **Figure 1**). Participants heard labeling phrases that contained a novel noun, e.g., "Look! Here is a *blicket*!" Participants then saw two new pictures below the sample picture: one picture had the same-shaped place as the sample but a different-shaped object (*place match*: e.g., a dome-shaped room with a rectangle-shaped block inside); and one picture had the same-shaped object as the sample but a different-shaped place (*object match*: e.g., triangle-shaped room with a hexagon-shaped block inside). Participants were then asked to extend the noun by finding "another *blicket*."

Because in these stimuli the place and object information were confounded with other more general spatial information, such as size (i.e., place information was always larger than object information) and figure-ground relations (i.e., object information was always the figure and place information was always the ground), we included another condition that matched the place condition in size and figure-ground relations but included only one spatial domain, objects. After Dillon (2021), this *object* condition presented participants with pictures in which the ground shape was shown as an open container so the figure and ground were both object parts. Participants in this condition heard the same labeling phrases and questions.

If young children and adults intuitively think nouns refer to objects, not places, then the participants in the place condition should extend the novel noun to the object over place information. If this effect is specific to objects and places as different spatial domains, then in the object condition, in contrast, participants should extend the novel noun equally to the object parts that serve as figure or ground.

Finally, to explore the origins of any object-over-place bias in language, we conducted a mini-corpus analysis (**Experiment 3**) using the CHILDES North American Corpora (MacWhinney, 2000). Here we evaluated how much and in what ways young children might receive different linguistic input about object nouns and place nouns.

Experiment 1

Methods

The preregistration is available at: https://osf.io/s8b4x/, and the use of human participants for this experiment was approved by the Institutional Review Board on the Use of Human Subjects at New York University.

Participants A sample of 72 native English-speaking adults (18- to 24-years-old) were recruited from New York University's participant pool and received course credit for their participation in this experiment. An additional 12 adults participated but their data were excluded following preregistered criteria: for taking longer than 15 minutes to complete the experiment (3); or answering one or both catch questions incorrectly (9; see below).

Stimuli The stimuli consisted of a set of pictures of 3D rendered places and objects generated in the animation software Blender (**Figure 1**). Rendered scenes were used to control for visual features, like color and texture, that may differ between places and objects in typical natural and man-made scenes. All stimulus pictures are available at: https://osf.io/sjqx7/.

The place pictures included a monochrome indoor scene of a room of one of eight shapes (rectangle, dome, isosceles triangle, regular hexagon, square, elongated hexagon, elongated pentagon, or elongated parallelogram) presented in a cool color (blue, purple, or green). To best convey the spatial context, i.e., that the places was navigable, the pictures included one 3D rendered cartoon person standing in the room. Each picture also included one object, which was one of the eight shapes that the place was not. The object was presented in a warm color (pink, red, or orange; **Figure 1**, *Place Condition*). The full set of place pictures varied in color and fully permuted the shape of the place with the shape of the object in it, resulting in 72 place pictures.

These 72 pictures allowed for two trials per participant that included completely different shapes and colors. One trial included the rectangle, dome, isosceles triangle, and regular hexagon. The other trial included the square, elongated hexagon, elongated pentagon, and elongated parallelogram. The two trials also used different shades of the six colors. Each trial contained three pictures: a sample picture of a place and an object each with a different shape (e.g., a dome-shaped room with a hexagon-shaped block inside); a place-match picture with the same-shaped place as the sample but a different-shaped object (e.g., a dome-shaped room with a rectangle-shaped block inside); and an object-match picture with the same-shaped object as the sample but a different-

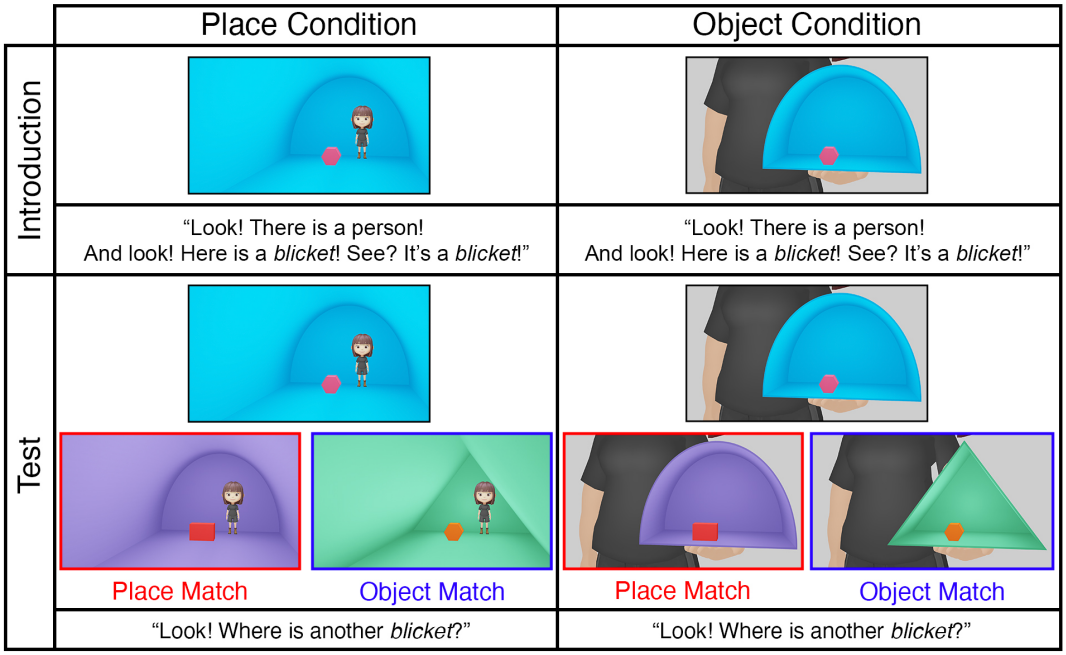

Figure 1: Schematic of the experimental materials and procedure.

shaped place (e.g., a triangle-shaped room with a hexagon-shaped block inside). The colors of the objects and places varied across all three pictures and were counterbalanced across participants.

Across participants: each of the eight shapes and each of the six colors was presented an equal number of times as the place match and object match; the place-match picture appeared on the left and right sides of the screen an equal number of times; and the place-match picture appeared on the same and different sides of the screen across the two trials an equal number of times. Half of the participants were shown the place-match picture on the left side of the screen on the first trial, and half of the participants were shown the place-match picture on the right side of the screen on the first trial.

A complementary full set of 72 object pictures (**Figure 1**, *Object Condition*) matched the place pictures in the shape of the figure and ground elements as well as in the size and position of these elements in the pictures themselves. To best convey the spatial context, i.e., that the object was manipulable, the pictures showed the same 3D rendered person, but here the person held the ground shape as if it was a kind of container displayed with its opening forward.

Procedure Participants completed the experiment online through the survey platform Qualtrics and without interacting with an experimenter. Participants were randomly assigned to the place or object condition and read instructions telling them how to view the experiment in their browser window and test their computer audio. Then, participants saw the two test trials, as described above. The sample picture first appeared at the top-center of the screen, and participants heard pre-recorded sentences that labeled the picture with a novel noun (e.g., "Look, there is a person! And look! Here is a *blicket*! See? It's a *blicket*!"; **Figure 1**). The person was explicitly labeled to eliminate it as a potential referent for the novel noun. Then, two test pictures—a place-match picture and an object-match picture—appeared below the sample picture, which remained visible. Participants were asked, "Where is another *blicket*?" They used their mouse to select one of the two response pictures, and they received no feedback. After making a response, participants answered a catch question, in which they selected which of four novel words they just heard, and they received no feedback. All participants heard the first sample picture labeled with the novel noun *blicket* and the second sample picture labeled with the novel noun *wug*.

Results

The data and analysis script are available at: https://osf.io/2h6uj/.

The data were analyzed using three preregistered mixed-effects logistic regressions, each including participants as a random-effects intercept. The first two intercept-only models tested adults' choice of the object match in each condition against chance performance and revealed that adults chose significantly more object matches than place matches in the place condition (Wald $\chi2 = 11.56$, $p < .001$; **Figure 2**, *Adults*). In contrast, we did not find a difference in adults' choice of the object match and place match in the object condition ($\chi2 = 0.19$, $p = .663$). A third model included a fixed effect for condition and revealed that adults chose the object match more in the place versus object condition ($\chi2 = 11.60$, $p < .001$).

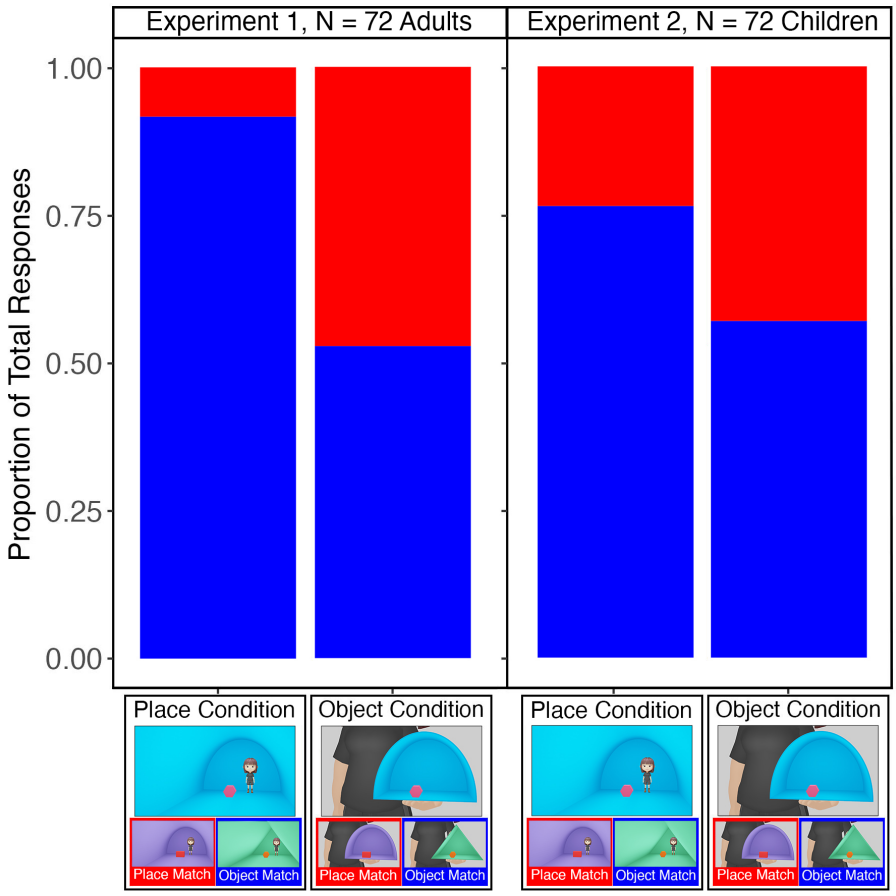

Figure 2: The proportion of adults' object-match responses and place-match responses in the place and object conditions in **Experiment 1**, and the proportion of children's object-match responses and place-match responses in the place and object conditions in **Experiment 2**.

Discussion

Adults' responses in the place condition of **Experiment 1** suggest that they extend novel nouns to objects over places. Their responses in the object condition suggest that this object-over-place bias is specific to differences in spatial domain as opposed to more general figure-ground relations: In the object condition, both the figure and ground shapes were object parts, and adults extended novel nouns to those object parts equally. In **Experiment 2**, we ask whether young children show this same object-over-place bias in word learning.

Experiment 2

Methods

The preregistration is available at: https://osf.io/jy789/, and the use of human participants for this experiment was approved by the Institutional Review Board on the Use of Human Subjects at New York University.

Participants A sample of 72 3- to 4-year-old children were recruited from our lab's database of families and at a local museum in New York City. All children were typically developing, learning English as a native language, and hearing at least 50% English. This age range was chosen based on prior studies using a similar noun-extension task (e.g., Cimpian & Markman, 2005; Landau et al., 1988) and based on prior studies on children's drawing production (e.g., Dillon, 2021). An additional 10 children participated but their data were excluded following preregistered criteria: for not making a valid response after a maximum of three prompts (3), not following the instructions (3), experimenter error (3), or interference from a caregiver (1).

Stimuli The stimuli were identical to those of **Experiment 1**.

Procedure Children participated in the experiment in person in a quiet room at the lab or at the museum. Prior to starting the experiment, an experimenter instructed caretakers to not interfere with children's pointing behavior, and children were randomly assigned to the place or object condition. Children sat on a chair facing a laptop, and the experimenter sat next to them and used a mouse to control the stimulus presentation

and record their responses through PsychoPy, an open-source software for creating and running psychology experiments (Peirce et al., 2019). The experimenter also produced all of the verbal instructions and questions live following a script. The script is available at: https://osf.io/jy789/.

Children first practiced pointing to one of two choices on the screen in four practice trials. For each practice trial, children were shown two black squares, one with a colorful still abstract figure and one with a colorful animated abstract figure. They were asked to point to "where something is happening" and received positive feedback after each correct response and corrective feedback after any incorrect response. Across the four practice trials, the correct responses were in one of two fixed locations, randomly assigned across children: left, right, right, left; or right, left, left, right.

Children then saw the two test trials, as in **Experiment 1** and were asked, "Where is another *blicket*? Can you point?" The experimenter clicked on the response they pointed to on the screen. If children did not provide a response, the experimenter prompted up to three times before moving on.

Results

The data and analysis script are accessible at: https://osf.io/hdx2w/.

The data were analyzed using the same three mixed-effects logistic regressions in **Experiment 1**, and two additional models tested the effects of age within the child sample and across the child and adult samples. The first two intercept-only models revealed children chose the object match more in the place condition (Wald $\chi2 = 17.90$, $p < .001$; **Figure 2**, *Children*). In contrast, we did not find a difference in children's choice of the object match and place match in the object condition ($\chi2 = 1.13$, $p = .289$). The third model including condition found that children chose the object match more often in the place versus object condition ($\chi2 = 5.14$, $p = .023$).

A fourth model including condition and age (treated as a continuous variable) within the child sample as fixed effects found a significant main effect of condition (place vs. object; $\chi2 = 5.11$, $p = .024$), with more object-match choices in the place condition, no effect of age (age in days; $\chi2 = 0.25$, $p = .616$), and no condition X age interaction ($\chi2 = 0.86$, $p = .352$). A fifth model, which included condition and age (treated as a categorical variable) across the child and adult samples, revealed significant main effects of condition (place vs. object; $\chi2 = 17.79$, $p < .001$), with more object-match choices in the place condition, and age (children versus adults; $\chi2 = 5.23$, $p = .022$), with more object-match choices in the adult sample, as well as a significant condition X age interaction ($\chi2 = 4.43$, $p = .035$): Both children and adults chose the object match more in the place condition; however, this difference between conditions was larger in the adults.

Discussion

Children's responses in **Experiment 2** showed that they, like the adults in **Experiment 1**, extend novel nouns to objects over places and that this effect is specific to spatial domain. While the strength of this object-over-place bias did not change from 3 to 4 years of age, adults did appear to show a stronger bias than did young children.

To explore the origins of this object-over-place bias in language, we conducted a mini-corpus analysis (**Experiment 3**) using the CHILDES North American Corpora (MacWhinney, 2000). Here we evaluated how much and in what ways children might receive linguistic input about object versus place information.

Experiment 3

Methods

We conducted a descriptive mini-corpus analysis of the CHILDES North American Corpora (MacWhinney, 2000) to explore similarities and differences in how much and in what ways caregivers use object nouns and place nouns in their utterances. To do so, we first used Wordbank's norming data (Frank et al., 2017) to identify the five object nouns and five place nouns that 12-month-old infants first come to understand. Then, we found all of the caregiver utterances that contained these ten nouns in the CHILDES corpora and compared their frequency for the object and place nouns. Finally, we compared the syntactic fames in which these object and place nouns were used.

Results

The first five object nouns that 12-month-old infants know are: ball; book; bottle; diaper; and shoe. The first five place nouns that 12-month-old infants know are: backyard; bathroom; bedroom; kitchen; and park. Given these nouns, we extracted 5,510 utterances from CHILDES containing these nouns. 86% of those utterances contained any one of the object nouns while just 14% contained any one of the place nouns.

In addition to this difference in frequency, caregivers also tended to use these object and place nouns in different syntactic frames. In particular, caregivers tended to label objects (e.g., "That's a *ball*"): 18% of phrases containing an object noun; 5% of phrases containing a place noun. In contrast, caregivers tended to use place nouns in the context of navigation (e.g., "Go to the *kitchen*"): 0% of phrases containing an object noun; 23% of phrases containing a place noun.

Discussion

The results from **Experiment 3** suggest marked differences in the relative frequency and context of occurrence of object nouns and place nouns in early linguistic experience. Such input may lead young children and adults to expect nouns to refer to objects, not places, consistent with the findings of **Experiments 1** & **2**. Moreover, **Experiment 3** suggests that the particular syntactic frame in which object nouns tend to appear, i.e., in labeling phrases, may have heightened the effects we observed in **Experiments 1** & **2**, which relied only on labeling phrases.

General Discussion

In two experiments, we found that when presented with a place condition, in which novel nouns could refer to either object or place information in a picture, both college-aged adults and 3- to 4-year-old children extended the nouns to the objects more than the places. In contrast, when participants were presented with an object condition, in which pictures presented two types of object information capturing the same size and figure-ground relations as in the place condition, children and adults extended the novel nouns to the two kinds of object information about equally. Our results thus suggest that young children and adults privilege objects over places as the referents of novel nouns. This object bias in word learning echoes the object bias in children's drawing production and suggests that the object bias might be shared across different forms of symbolic expression.

What might be the origins of this object bias? We explored one possible source in a third experiment, which suggested that caregivers use nouns that refer to objects more frequently than they use nouns that refer to places, especially in labeling phrases like those used in our first two experiments. Such linguistic input may contribute to young children's and adults' object-over-place bias in word learning.

A second possible source of this object bias might be early non-linguistic experience with objects and places. Studies focusing on the development of infants' motor behaviors have revealed, for example, that infants begin to interact with objects much earlier than they begin to move around places on their own (Adolph & Franchak, 2017; Rochat, 1989). In addition, younger infants' line of sight limits their view of walls and other features of the extended surface layout and accentuates their view of objects (Kretch et al., 2014; Smith et al., 2018; Soska et al., 2010). Infants' visual experience based on their postural development, moreover, affects their language learning (Libertus & Violi, 2016; Walle & Campos, 2014; Yu & Smith, 2012). Infants' object-focused visual experience may thus contribute to an object-over-place bias in word learning (Smith et al., 2002; Smith, 2003).

A third possible source of this object bias might be greater selective attention to objects over places, especially in childhood. For example, Darby et al. (2021) presented 4- to 6-year-old children and adults with a rapid succession of pictures, each composed of a place, like a beach, and an object, like a car, and participants were told to either attend to the objects only or the places only. Participants were then asked to indicate if the spatial information they were told to attend to repeated across consecutive pictures. Children had more difficulty attending to the places (while ignoring the objects) compared with attending to the objects (while ignoring the places). Adults, however, were equally successful at attending to the object and place information. Language may be more likely to pick out spatial information we more easily attend to, and so early biases in selective attention might relate to an object-over-place bias in word learning, especially in childhood.

A fourth possible source of this object bias might lie in foundational differences in the way not only humans, but also non-human animals, interact with objects and places for everyday recognition and navigation. In particular, while humans and non-human animals tend to use geometry automatically to determine their position in space (e.g., Cheng & Newcombe, 2005; Hermer & Spelke, 1996), they tend to learn their position in space explicitly relative to the location of landmark objects (e.g., Doeller & Burgess, 2008; Doeller et al., 2008). Children and adults may thus expect that language, which is explicit and communicative, is more likely to pick out objects, whose spatial information is used explicitly during navigation.

Given the possible linguistic and non-linguistic sources of this object-over-place bias, future studies should explore how specific this bias is to particular linguistic contexts, especially those that include labeling phrases. For example, previous word-learning studies focusing on objects have found that young children show either no or an attenuated shape bias when presented with unlabeled sample objects and are asked to find new objects that "match" or "go with" the sample (e.g., Diesendruck & Bloom, 2003; Jones et al., 1991; Landau et al., 1988). Follow-up experiments might thus present young children and adults with the same stimuli as those used in the present experiments, but pair them with non-labeling phrases like, "Look over here! See that? Can you find the one that matches?" If an object-over-place bias is specific to labeling phrases, then such an experiment should find no object bias when participants hear such non-labeling phrases. If, however, participants are guided by a general bias to attend to objects over places, or their bias is activated with any accompanying language, then such a study should still find an object bias. Along similar lines and given the results of **Experiment 3**, in which objects nouns are used more often than place nouns in labeling phrases, future studies should also explore whether other syntactic frames might better convey that a novel noun refers to a place. Follow-up experiments might thus present phrases like "Go to the *blicket*!" or "It's inside the *blicket*!" (Landau & Stecker, 1990). More generally, exploring the conditions in which young children preferentially extend nouns to objects over places may help broaden our understanding of how foundational cognition, experience, and linguistic form and content contribute to children's learning of words that refer to different spatial domains.

Finally, the present experiment's tasks focused on noun extension based on shape information, the geometry typically used to recognize objects, not navigate places. In doing so, the present study assumed that participants were equally capable of extending shape information to both places and objects, which may not be the case (Landau & Jackendoff, 1993; Landau & Stecker, 1990; Talmy, 1983). Future studies should thus examine, for example, whether children and adults demonstrate a kind of "shape bias" for places, i.e., that they are capable of and inclined to extend novel nouns to places of the same shape.

Our present findings provide a new insight about the intuitions that guide word learning: Spatial domains specifically—over and above more general spatial

information like figure-ground relations—are important to our learning the meaning of nouns. By expanding the spatial domains of prior studies, the present study contributes to a more comprehensive description of children's intuitions about the spatial world and the language and symbols used to describe it.

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