The Development of Mutual Exclusivity and Early Language Experience in Infants' Adjective Mapping

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PROJECT SUMMARY

My proposed longitudinal study is to investigate how infants of different language background use logical inference such as mutual exclusivity in adjective mapping at 14 month olds and 21month olds. The participants will be 16 monolinguals and 16 bilinguals. In the first experiment studying 14-month-old infants, they will be exposed either to line-drawn dogs or cats. Each dog and cat have a unique combination of color and texture. Infants will be familiarized with an object (e.g., a smooth, purple cat) with a known name (e.g., "cat") and another within-category object (e.g., a spotted, aqua cat) with a novel adjective label (e.g., "zabe"). Infants will then be tested on their preference among the color-matched object (e.g., a smooth, aqua cat), the texture-matched object (a spotted, orange cat), and the kind-matched object (e.g., a bumpy, pink cat), when they hear the word "zabe." The second experiment is similar except the objects presented are cars and planes and the novel property label is "dax." As evidence has shown that bilinguals are less restrained by mutual exclusivity than monolinguals in their early language development, I predict that bilinguals will accept the novel adjective label as another category label, but monolinguals will map it to the object's property. Moreover, I predict that this weaker mutual exclusivity phenomenon occurs later in bilinguals' language development, at around 21month olds.

SIGNIFICANCE

Adjectives are important for human mind to construct categorization, as they are closely linked with taxonomic information and can have complex, conceptual connotation (Madikhanova, 2021). Unlike the learning of nouns, adjective acquisition happens relatively late in children's language development. For one thing, adjectives do not have a consistent mapping between form and meaning as nouns do. The meaning expressed in adjectives can be conveyed by nouns or verbs in languages with a restricted number of adjectives (Dixon, 2010). Even in adjective-rich languages such as English, a word can be both an adjective or a noun (e.g., square) and adjectives do not necessarily indicate a referent's properties (e.g., prior, which stresses the nominal concept's state and relation to the others). For another, the noun bias has impeded children's adjective acquisition to some extent. When interpreting a novel substance term (e.g., pewter), preschoolers have been found to treat the new word as referring to the whole object other than its property, which is known as the whole object bias (Markman & Wachtel, 1988; Soja et al., 1991). Also, children's adjective learning is bounded by their knowledge of nouns. Mintz & Gleitman (2002) showed that toddlers who heard a novel adjective followed by "one" instead of a concrete noun (e.g., "a stoof one" vs. "a stoof horsie") failed to map the novel adjective to the object property. Similarly, Sandhofer & Smith (2007) discovered that children who learned more nouns performed better in learning color words, when presented with syntactic cues advantageous to adjective acquisition (e.g., "This is a red bear," object modifier) compared to the ambiguous ones (e.g., "This is a red," noun construction).

Since the linguistic ambiguity and the whole object bias make adjective acquisition a more difficult learning task, researchers have explored various methods to facilitate children's interpretation of adjectives. Linguistic cues like emphasizing an adjective's salient feature as an object modifier supported children's comprehension of novel adjectives (Mintz & Gleitman 2002; Sandhofer & Smith 2007). Extralinguistic cues such as gestures and exemplar comparisons have also been shown to aid in children's adjective acquisition. The descriptive gestures (e.g., squeezing the toy) helped children identify the novel adjective term (e.g., spongy), in marked contrast to the group viewing the point gestures (O'Neill et al., 2002). Teaching a novel adjective by exhibiting

a common property across multiple exemplars (i.e., across basic level categories) advanced children's property-matching behaviors (Mintz & Gleitman, 2002). Numerous research regarding adjective acquisition has focused on this external manipulation of highlighting an adjective's tangible modifying function and filtering irrelevant information, but little has sufficiently investigated how children's logical inference could help themselves distinguish the adjective from other parts of speech. Hence, my proposed study is motivated to explore cognitive, logical factors that play a role in children's adjective learning.

INNOVATION

Mutual exclusivity is one pronounced type of logical inference employed by children in their early language development. Using this strategy, children assume that only one label matches to one object (e.g., a child presumes that a cat has only one label "cat"). Although past studies have extensively studied how children as young as 24-month-old heavily relied on mutual exclusivity to map novel words, not many have discussed the use of mutual exclusivity in adjective mapping and most studies considering mutual exclusivity have focused on monolinguals (Graham et al., 2010; Markman & Wachtel, 1988; Markman et al., 2003). Kandhadai et al. (2016) have shown that 18-month-old bilingual infants regarded the novel word (e.g., "zabe" referring to aqua) as a second category label for the familiar object (e.g., "dog"), while their monolingual peers preferred to interpret it as a property label on the across-category trial (e.g., an aqua-colored cat vs. a purple dog), consistent with previous studies' results that implied bilinguals had different interpretation of novel words as well as different development of mutual exclusivity because of their experience in learning translation equivalents (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010). Hence, I consider mutual exclusivity and early language experience as two variables of interest in my proposal.

Meanwhile, it remains uncertain when monolinguals and bilinguals start to use mutual exclusivity for word mapping and when they become less affected by this shortcut. Some research has shown that 14-month-old monolinguals and bilinguals both succeeded in a basic associative word-learning task, but 17- to 18-month-old

infants exposed to multiple languages failed to associate novel nouns with novel referents (Byers-Heinlein & Werker, 2009; Byers-Heinlein et al., 2013). However, other evidence has suggested that bilinguals did not adhere differently to mutual exclusivity compared to monolinguals before the age of three (Frank & Poulin-Dubois, 2002). Because of these mixed results and the gap between developmental age, I intend to investigate the development of mutual exclusivity as the third variable of interest. As infants as young as 14-month-old were able to distinguish nouns from adjectives based on naming cues and 21-month-old infants successfully extended a novel adjective to the property of the same basic level category objects, I will conduct a longitudinal study examining 14- and 21-month-old monolinguals and bilinguals' adherence to mutual exclusivity in adjective mapping, shedding light on how preverbal infants' logical inference and early language experience might impact their adjective acquisition (Waxman & Booth, 2001; Waxman & Markow, 1998).

APPROACH

My first experiment will examine the mutual exclusivity for mapping adjectives in 14-month-old infants. I intend to recruit 16 monolingual English-exposed infants (eight female, eight male) and 16 bilingual infants (eight female, eight male). Infants' language exposure will be calculated according to a modified version of the Language Exposure Questionnaire (Bosch & Sebastián-Gallés, 2001). My proposal's study design is adapted from Kandhadai et al. (2016). Infants will be presented with line-drawn animals on a TV screen and go through three types of trials with corresponding audio labeling (see Table 1). Different from the previous study's setup, I modify visual stimuli, the meaning of the novel adjective, and the trial setting. I integrate the texture property into the visual stimuli because infants might have prepotent bias toward a certain property and texture terms have appeared relatively early in children's lexical development (Waxman & Markow, 1998; Waxman & Booth, 2001). Hence, the animal visual stimuli (cat and dog) will always be shown with two properties, a texture property (smooth, spotted, or bumpy) and a color property (purple, orange, pink, or aqua). Also, the novel label "zabe" refers to an animal's property without pre-determined mapping to the texture or the color, in order to see whether infants have a preference over which property to match. Lastly, the across-category animal

is no longer included in one experimental condition, because the additional property feature increases the task's complexity. In the familiarization trials, there are two visual stimuli from the same category, one labeled with a known category name (e.g., cat) and the other labeled with a novel adjective label (e.g, "zabe"). After the familiarization phase, there is a 20-second break where a cartoon clip is played on screen. In the test trials, three visual stimuli sharing one commonality with the familiar "zabe" object are in a row: a texture-matched object, a color-matched object, and a kind-matched object. During the test trials, the audio stimuli change from single words to "Ah! ____", "Oh! _____," and "Look! _____" to attract infants' attention. Infants' looking time to each stimulus will be recorded by a Tobii ET-17 binocular corneal-reflection eye-tracker (Frank et al., 2009).

Trial	visual	audio	visual	audio
familiarization	smooth, purple cat	"cat"	smooth, purple dog	"dog"
	spotted, aqua cat	"zabe"	spotted, aqua dog	"zabe"
familiar label test trial	smooth, purple cat vs. spotted, aqua cat	"cat"	smooth, purple dog vs. spotted, aqua dog	"dog"
	smooth, purple cat vs. spotted, aqua cat	"zabe"	smooth, purple dog vs. spotted, aqua dog	"zabe"
within-cagetory novel label test trial (texture vs. color vs. kind)	spotted, orange cat vs. smooth, aqua cat vs. bumpy, pink cat	"Oh! zabe!"	spotted, orange dog vs. smooth, aqua dog vs. bumpy, pink dog	"Oh! zabe!"
	bumpy, pink cat vs. spotted, orange cat vs. smooth, aqua cat	"Aha! zabe!"	bumpy, pink dog vs. spotted, orange dog vs. smooth, aqua dog	"Aha! zabe!"
	smooth, aqua cat vs. bumpy, pink cat vs. spotted, orange cat	"Look! zabe!"	smooth, aqua dog vs. bumpy, pink dog vs. spotted, orange dog	"Look! zabe!"

Table 1. *Stimulus sets used in the first experiment*

Within each language group (monolinguals vs. bilinguals), infants will be randomly assigned to one set of stimuli. During the familiarization phase, infants will experience two familiarization trials (one trial with a known animal label, the other trial with a novel property label) seven times with a randomized order. One object appears on the screen for each familiarization trial, and each familiarization trial lasts 18 seconds long. The greater number of repetitions and longer familiarization phase is due to the presentation of two properties. After

the familiarization phase, there is a 20-second break where a cartoon clip is played on screen. Infants then get tested on the two familiar objects, where they are exhibited in a row. Their position on the screen's left or the right side is randomly assigned. and infants' looking time to each object will be recorded. They will proceed to the novel test trial if they continue looking longer at the target object for the two familiar label test trials. Each within-category novel label test trial is 14 seconds long. The test trials are invented to test whether infants decipher the novel adjective as a second category label or a property label. A novel label trial has fixed three visual stimuli (a texture-matched cat; a color-matched cat; a kind-matched cat) and is presented three times because of counterbalancing. Infants' looking time to each object will be recorded per trial and averaged across three trials. My second experiment will be a follow-up study on the same group of infants when they are 21-month-old. The experimental design will be the same as the first experiment, except that the animals are changed to transportation (e.g., cars and planes) and the novel property word is "dax."

I will also conduct one-way ANOVA to see whether the average looking time in each stimulus type (i.e., texture-matched vs. color-matched vs. kind-matched) is significantly different for each linguistic experience group. My predictions will be that both 14-month-old monolingual and bilinguals look longer to the object matched in color (e.g., smooth, aqua cat) than the object matched in texture (e.g., spotted, orange cat) and the object matched in kind (e.g., bumpy, pink cat), since they use mutual exclusivity and find commonalities across objects in color more easily than in texture. However, 21-month-old bilinguals look longer at the kind match, because their mutual exclusivity is weaker after long-term multiple language exposure. Also, 21-month-old monolinguals have similar looking time for the object matched in color and the object matched in texture, for their growing experience with texture lexicon (See Fig 1 and Fig 2). I will also conduct an independent t-test to examine whether the looking time of monolinguals and bilinguals in each type of match category significantly differs. My predictions will be that 14-month-old monolinguals and bilinguals do not perform differently in the adjective mapping task but 21-month-old bilinguals have a pronounced tendency to map the novel property as a category label, due to the varied development of mutual exclusivity between monolinguals and bilinguals.

These results can show a developmental stage of mutual exclusivity influenced by early language exposure and mutual exclusivity's application in infants' adjective mapping, which further suggests preverbal infants' logical capability in word learning.

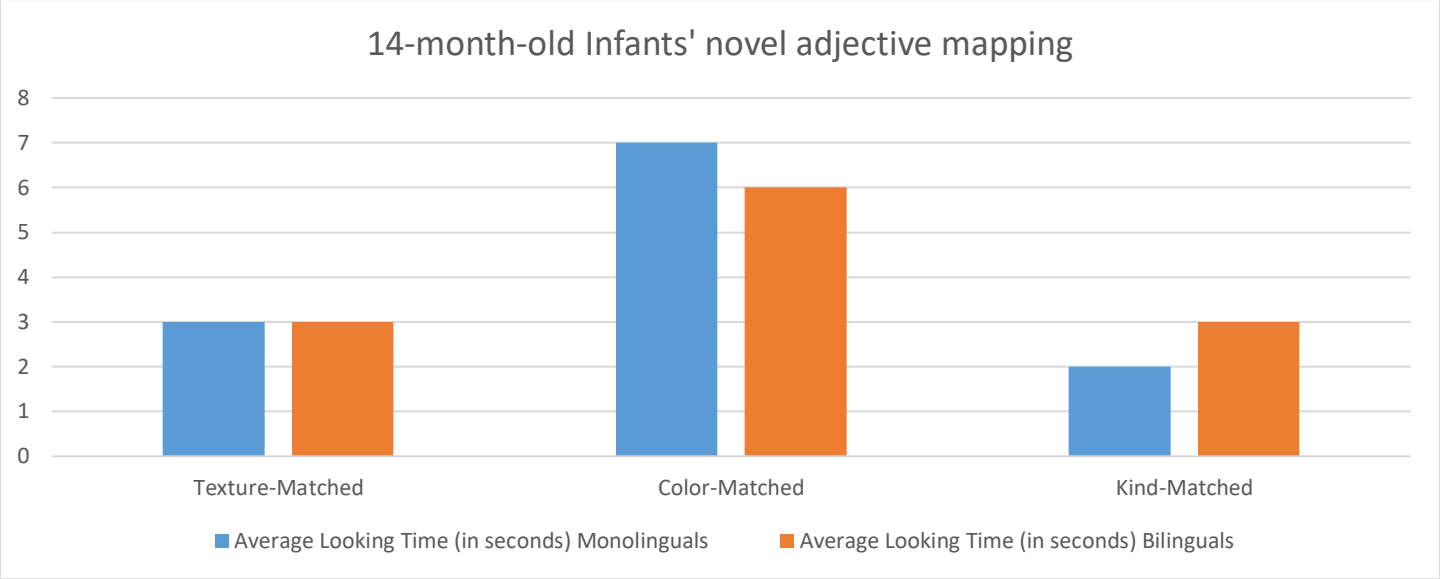

Fig 1. *Predicted Average Looking Time in 14-month-old infants' novel adjective mapping*

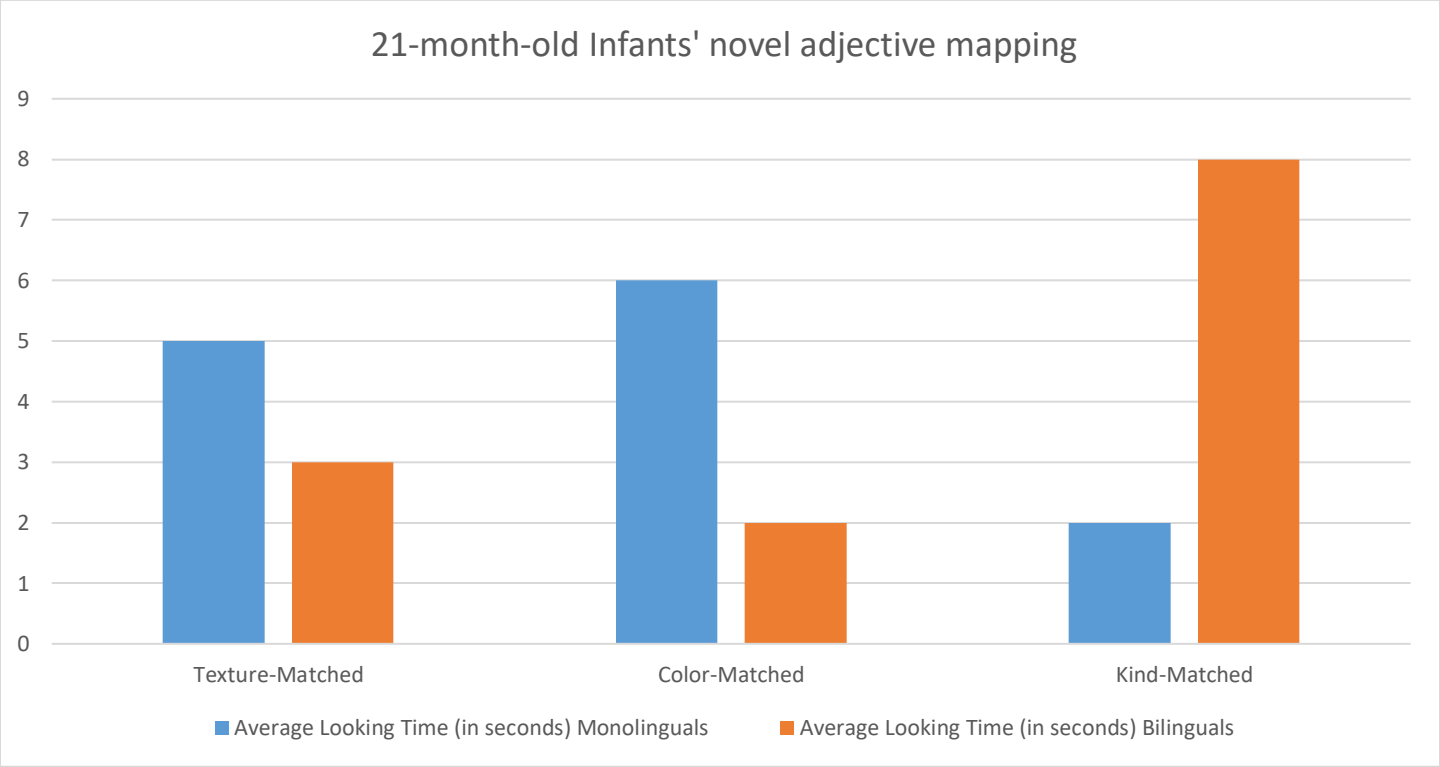

Fig 2. *Predicted Average Looking Time in 21-month-old infants' novel adjective mapping*

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