One-trial Learning in 2-year-olds:

Children Learn New Nouns in 3 Seconds Flat

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Abstract

We used a preferential pointing task to investigate 2-year old children's ability to infer the referent of a novel noun from a single ambiguous exposure, and their ability to retain this mapping. On critical trials, images of a known and a novel object (e.g. a ball and a nameless artifact constructed in the lab) appeared on two computer screens and a voice asked the child to "point at the [e.g. spoov]." Children saw 6 novel label trials (e.g. "spoov") and 20 known label trials (e.g. "ball"). Following label onset, children had only 3 seconds in which to infer the correct referent. Each novel object appeared only once during the study and no feedback was given. Children successfully pointed to novel objects on novel label trials and to known objects on known label trials. In a final post-test trial, two previously labeled novel objects appeared and children were asked to point to one of them (e.g. "spoov" versus "pizer"). In order to succeed on this trial, children had to have initially mapped the novel labels correctly and retained these mappings over the course of the study. Children succeeded on this post-test trial. We conclude that 2-year-olds are able to fast-map novel nouns from a single, 3-second ambiguous exposure.

Introduction

Children are able to create a novel entry in the lexicon for a newly heard word given only

minimal exposure to that word and its referent. This ability, called "fast-mapping" (Carey, 1978;

Carey & Bartlett, 1978), has been observed in children as young as 2;0 (Mervis & Bertrand, 1994;

Behrend, Scofield & Kleinknecht, 2001; Jaswal & Markman, 2001), and may be an integral part of the

machinery that supports children's impressive word-learning abilities (Carey & Bartlett, 1978; Rice,

1990)[1].

The study of fast-mapping has focused on what children can learn about a new word given only

a few exposures to this new label under conditions of unambiguous labeling (*for recent reviews see*

Woodward & Markman, 1998; Jaswal & Markman, 2001; Wilkinson & Mazzitelli, 2003).

Experimenters have successfully elicited fast-mapping by ostensively drawing children's attention to

the referent via pointing, eye-gaze or an explicit linguistic contrast (e.g. "bring me the *chromium* tray,

not the red one, I want the *chromium* one." Typically, the correct referent is the only object present

(Dickinson, 1984; Holdgrafer & Sorensen, 1984; Dollaghan, 1985; Au & Glusman, 1990; Woodward,

Markman & Fitzsimmons, 1994; Baldwin, Markman, Bill, Desjardins, & Irwin, 1996; Markson &

Bloom, 1997; Waxman & Booth, 2000; Behrend et al., 2001; Jaswal & Markman, 2001; Waxman &

Booth, 2002). Recent work has extended these demonstrations of fast-mapping to more ambiguous

labeling acts, showing that 2-year-olds can learn as much about a new word from an indirect exposure

as from an act of ostensive labeling (Jaswal & Markman, 2001 *but for related results see* Vincent-

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[1] The ability to quickly learn and recall facts about objects has been observed in children as young as
3;0 (Markson & Bloom, 1997; Waxman & Booth, 2000; Behrend et al., 2001) and may reflect a
general ability to encode and recall information about individuals when that information is not readily
identifiable from the environment (e.g. the name & origin of an object versus its outside
coloring)(Bloom, 2000: 34).

Smith, Bricker & Bricker, 1974; Rice, 1990; Golinkoff, Hirsh-Pasek, Bailey & Wenger, 1992; Mervis & Bertrand, 1994; Wilkinson & Mazzitelli, 2003)[2].

In natural situations, young word-learners are surrounded by many objects for which they do not yet know a name, and they hear many novel labels in quick succession. This stands in stark contrast with the most common laboratory word-learning situation in which children learn only a few object names (most often only one), the novel label may be presented as many as nine times (Woodward et al, 1994), and the object being referred to is clearly indicated. Recently, some authors have noted these disanalogies between the natural environment and the laboratory word-learning situation (Jaswal & Markman, 2001; Wilkinson & Mazzitelli, 2003). If 2-year-olds are learning multiple new words in quick succession, and if the referent of these labels is often ambiguous, the empirical study of fast-mapping has yet to test children under such conditions. The present work focuses on two questions: can children learn multiple novel labels at the same time, and how much guidance is necessary to motivate children to fast-map?

We presented children with novel objects named in ambiguous labeling acts (e.g. a novel and a familiar object were presented on two computer screens and children were told to "point at the [e.g. spoov]"). The speaker of this labeling act was hidden from view (i.e. a recorded voice on a computer), eliminating any ostensive cues that might have guided word-learning. Children had to infer which object was the referent of the novel label, and they were given a total of 3 seconds to do so. This procedure investigated the robustness of fast-mapping abilities in that children were presented with completely ambiguous labeling acts and were given only 3 seconds to identify the correct referent and potentially fast-map this new word.

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[2] Work on fast-mapping has also shown that children can retain a newly learned word for a significant amount of time following the initial encounter. In the original demonstration, Carey & Bartlett (1978) showed that children remember some semantic information about a label more than one week after a single encounter with it. Markson & Bloom (1997) extended this result and showed successful retention at delays of up to one month after the initial exposure to a new word. Other studies such as

Children saw 12 novel objects and heard 6 novel labels over the course of a 15-minute study session. Children also saw 34 familiar objects and heard 20 familiar labels during this session. For both novel and known labels, children had a total of 3 seconds to parse the label, map it to the correct object and point to that object. Children heard each label only once, and each novel object appeared only once. No feedback was given. Following the study session, we tested whether children had retained these novel labels over the course of the experimental session.

Method

Participants

Participants were 34 two-year-olds (16 male) from middle-class homes where English was the primary language spoken (mean age = 2;7, range = 2;3 to 2;11). An additional 27 children participated but were removed from the sample for the following reasons: parental interference (8), response side bias (7), fussiness (4), and refusal to point (8).

Procedure

Our method can be considered an extension of that used by Vincent-Smith et al. (1974) with the exception that we gave no feedback during the study. Vincent-Smith et al. (1974) tested 2-year-old children's ability to infer the referent of an ambiguous label, and later tested children's retention of the mapping from this label to its novel referent. We presented 2-year-olds with similar trials. In our study, a typical trial consisted of two objects appearing on two computer screens [e.g. a ball on one screen and a novel object for which children did not know a name (phototube) on the other].

Wilkinson & Mazzitelli (2003) have shown that children will retain information about a new label over the course of intervening trials within a single study session.

Simultaneously, the computer played a labeling phrase that correctly labeled only one of the objects (e.g. "Point at the [e.g. spoov]"). After the onset of the label (e.g. "spoov"), children had a total of 3 seconds to infer which object was being referred to (e.g. phototube), to point to this object, and potentially to fast-map enough information about this mapping to retain it for later recognition.

The study began with 4 practice trials that included only known objects. Next, children saw 24 test trials and one post-test trial that tested novel label retention. On six of the 24 test trials, a novel object was the labeled target. On these trials, the distractor object was an object for which the child knew a name (e.g. a ball) (parents filled out a brief inventory of their child's known word vocabulary before the study began, and all parents reported that their children knew the names of the objects used on these trials). Children were expected to use Mutual Exclusivity on these trials to infer that the novel label (e.g. "dax") referred to the novel object (e.g. phototube). Mutual Exclusivity is the principle that every object has just one name (Markman & Wachtel, 1988; Merriman & Bowmnan, 1989 *for related principles see* Golinkoff et al, 1992; Clark, 1993; Diesendruck & Markson, 2001). Children as young as 17 months have been observed to use this principle to infer the referent of an ambiguous novel noun (e.g. "dax") under similar conditions to those used in the present study (Mervis & Bertrand, 1994; Halberda, 2003).

On the remaining 18 trials, a known object was the labeled target (e.g. a telephone), and children again had to point to the label's referent. On the post-test trial, children were presented with two novel objects, each of which had been seen once earlier as a labeled target object (e.g. "spoov" and "pizer"). The labeling phrase instructed children to point to one of these objects using the novel label previously used for that object (counterbalanced across subjects and orders). Children who pointed at the correct object were coded as having successfully fast-mapped the name of the novel object.

Two pseudo-random trial orders were constructed with the constraint that two Novel Label trials did not appear consecutively and that a target object did not appear on the same computer screen

(i.e. left or right screen) more than twice in a row. The objects and labels used are presented in Table 1.

INSERT TABLE 1 ABOUT HERE

Visual stimuli consisted of 48 computer generated "3-D" objects from the TarrLab Object Data Bank (1996). Twelve of these were novel objects that we constructed in the laboratory by combining parts of known object images to create nameless artifacts. Auditory stimuli consisted of 24 labeling phrases recorded by a native English speaker, played over computer speakers. The target label appeared in sentential final position after a carrier phrase (i.e. "Point at the ___"). Each novel object appeared only once during the study (with the exception of the post-test trial).

Participants were tested in a sound-attenuated room. They were seated facing two computer monitors that were approximately 50 cm away and 72 cm apart at their centers. Caretakers, when present, were seated approximately 4 feet directly behind the child, visible to the experimenter, and could not influence the child's performance. The computer screens were surrounded by a curtain behind which the experimenter stood to control the computer. Thus, the only input to guide children's pointing was the labeling phrase played by the computer speakers. Children were told that they were participating in a word-game, and that their task was simply to follow the instructions to "Point at the object" as fast as possible. Two-year-olds found this to be an intrinsically rewarding game and they were eager to participate.

To control for baseline object preference, each familiar object appeared twice during the study, once as a target and once as a distractor. Children received no feedback as to whether they had pointed correctly or incorrectly.

Results

Pointing was coded after the study from videotape by observers who were blind as to which screen depicted the labeled target. Children pointed before trial offset (the end of the 3 seconds following the spoken label) on 70.2% of Known Label trials (e.g. "Point at the ball") and on 64.3% of Novel Label trials (e.g. "Point at the spoov"). Points were scored as correct/incorrect and mean percent correct was computed for each Trial Type (Known, Novel) for each subject. Because there were always 2 objects presented on each trial, chance pointing is 50% correct. These subject means entered into 2 Trial Type (Known Label, Novel Label) X 2 Order mixed ANOVA which revealed no effect of Order: $F (1, 27) = 1.32$, $p = .261$, and a significant effect of Trial Type: $F (1, 27) = 10.02$, $p < .005$ in that children were more accurate on Known trials (92%) than Novel trials (73%). Planned *t*-tests compared percent correct to the chance level for both Known and Novel Label trials. Children successfully pointed to the labeled target on Known Label trials (Mean = 92%, $t (33) = 18.32$, $p < .001$) and on Novel Label trials (Mean = 73%, $t (28) = 3.40$, $p < .003$). Thus, 3 seconds of exposure is enough time for two-year-olds to parse and recognize a label as novel, infer the referent of this label, and point to it.

Our second question was whether children could remember <u>which</u> novel label referred to which novel object. This was not necessarily a simple task given that the children had heard each novel label only once and that they had seen a total of 12 different novel objects. A planned binomial test on the post-test trial revealed that children did in fact retain these mappings. Of the 19 children who pointed on the post-test trial, 15 of them pointed to the correct novel object, $p < .02$. These results are summarized in Figure 1.

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INSERT FIGURE 1 HERE

General Discussion

Previous research on children's ability to quickly form approximate lexical entries for newly

encountered words (i.e. "fast-mapping") has revealed that: 1) children as young as 2;0 can fast-map

(Vincent-Smith et al, 1974; Mervis & Bertrand, 1994; Behrend et al, 2001), 2) children can retain these

mappings for up to one month after their initial exposure (Carey & Bartlett, 1978; Markson & Bloom,

1997), and 3) indirect exposure to a new word can be as powerful as ostensive labeling in fast-mapping

(Jaswal & Markman, 2001). In the present paper we asked whether 2-year-olds can learn novel

common nouns from a single ambiguous exposure that lasts only 3 seconds, and can they learn

multiple nouns at the same time. That children succeeded at this task demonstrates the robustness of

the ability to fast-map. Two-year-olds can create a lexical entry for a novel noun heard only once in an

ambiguous labeling act, and can do so for at least 6 new words (the number of novel labels presented

to children in the present study). These entries are rich enough to allow children to learn multiple

novel nouns and to distinguish one novel noun from another in a post-test trial (i.e. that novel object A

is called "spoov" and not "pizer"). Future work will ask if children's ability to rapidly learn novel

facts (e.g. "this is the one my uncle gave me") is similarly robust, or if the fast-mapping of multiple

tokens from single ambiguous exposures is unique to word-learning.

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Figure Captions

<u>Figure 1</u>. The percentage of trials on which children pointed to the correct object (chance = 50%). Children successfully pointed to known targets, e.g. "ball" (*p* < .001) and novel targets, e.g. "spoov" (*p* < .003). Children's success on Novel Label trials indicates that 3 seconds (from novel label onset to trial offset) is long enough to allow children to parse the label, recognize it as novel, infer the referent of this label and correctly point to the novel object. On the post-test trial of fast-mapping, two previously labeled novel objects appeared (e.g. spoov and pizer) and children were asked to point to one of them (e.g. "point at the spoov"). Children successfully identified the correct novel target on this trial (*p* < .02) indicating that children had fast-mapped enough information from the single, original novel label trial to correctly identify the referent.
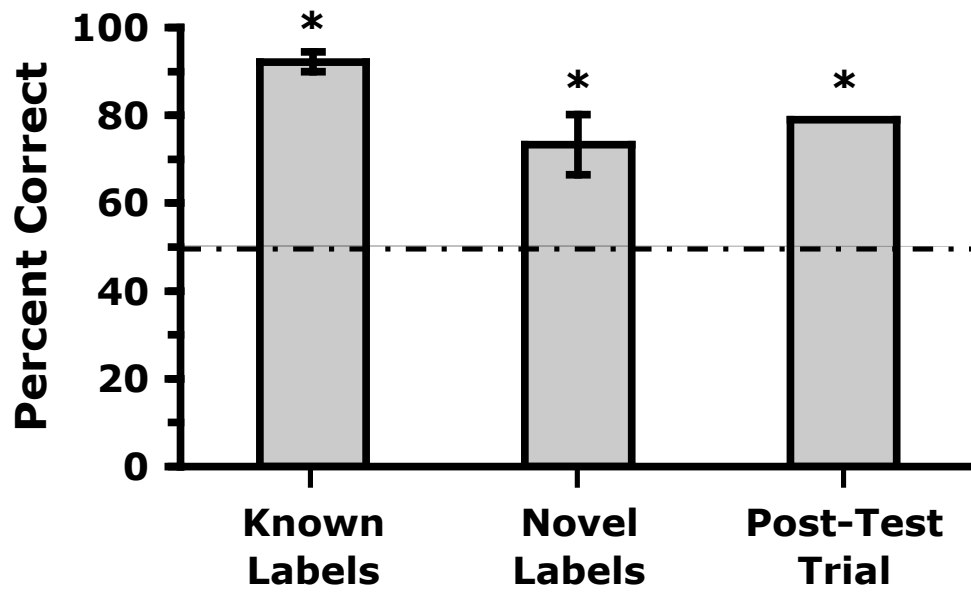
Figure 1

Table 1

The Known and Novel Labels Used in Experiment 1

	Known Labels (Distractor)		Novel Labels (Distractor)
ball (car)	clock (door)	knife (clock)	blick (spoon)
bed (cup)	cup (ball)	pen (novel)	dax (glasses)
belt (knife)	door (bed)	pencil (novel)	glark (belt)
bicycle (pencil)	fork (novel)	pumpkin (scissors)	pizer (fork)
car (hat)	glasses (novel)	scissors (novel)	spoov (bike)
chair (novel)	hat (pumpkin)	spoon (pen)	tanzer (chair)