Context in Word Learning: Word Learning in Context

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TABLE OF CONTENTS

Chapter

LIST OF FIGURES

CHAPTER 1

Introduction

When children hear a new word, they are often presented with a perceptually rich and somewhat chaotic environment (e.g., Horst & Simmering, 2015; Medina, Snedeker, Trueswell, & Gleitman, 2011; Trueswell et al., 2016). Take, for example, a toddler who hears the word *asparagus* for the first time during dinner while her father places the vegetable on her plate. In this scenario, the most relevant features of the scene for word learning are the label *asparagus* and its referent, the actual asparagus. However, those are not the only features of the environment available to the child. In addition to the label and its referent, our young word learner has visual access to other objects on the dinner table, which may be familiar or unfamiliar to her. The child is also experiencing this labeling episode within a specific setting: mealtime in a certain room. None of these features are directly relevant to learning the meaning of *asparagus*. Nevertheless, it is possible that irrelevant context features could affect word learning (e.g., Sandhofer & Schonberg, 2020). Interestingly, a growing body of research offers conflicting accounts of whether context affects word learning. In some cases, background context variability disrupts word learning (e.g., Goldenberg & Sandhofer, 2013a; Vlach & Sandhofer, 2011). In other cases, word learning is unaffected by background context variability (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). This dissertation will investigate whether the variability in more complex background contexts disrupts young children's word learning more than the variability in less complex backgrounds.

As a construct, context has been defined rather broadly in research (e.g., Akman, 2000; Akman & Surav, 1997; see Faber & León-Araúz, 2016 for a review). In this paper, I focus on environmental context, which refers to perceptible features surrounding an individual (see S. Smith, 2013 for a review). Within different literatures, however, environmental context can take on distinct meanings. In work on adult memory, for example, context has been operationalized as physical location (e.g., Godden & Baddeley, 1975), ambient odor (e.g., Herz, 1997), and ambient noise (e.g., S. Smith, 1985). In memory research with infants, context has referred to more local features, such as the pattern of a crib bumper (e.g., Fagen et al., 1997; Hartshorn et al., 1998; Rovee-Collier & Dufault, 1991). In both literatures, environmental context includes ambient features that are not relevant to an individual learning a piece of target information.

For centuries, researchers and scholars have speculated about the role context may play in memory retrieval. For example, the empiricist philosopher John Locke relayed a story about a man who learned to dance in the presence of a particular trunk and was later unable to dance in its absence (Locke, 1690). Since Locke's (1690) anecdotal account, a great deal of research has explored how ambient context affects memory. Within this substantial body of work, a clear pattern has emerged: similarities between learning environments and later retrieval environments tends to facilitate memory, whereas dissimilarities tend to disrupt memory (e.g., S. Smith, 2013; S. Smith & Vela, 2001). These effects emerge in both adults (e.g., Bilodeau & Schlosberg, 1951; Godden & Baddeley, 1975; 1980; S. Smith, Glenberg, & Bjork, 1978; S. Smith & Handy, 2014; S. Smith & Manzano, 2010) and infants (e.g., Amabile & Rovee-Collier & Dufault, 1991; Barnat, Klein, & Meltzoff, 1996; Hayne, Boniface, & Barr, 2000; Rovee-Collier, Griesler, & Earley, 1985). Effects of context on memory emerge even though the manipulated context features are irrelevant to learning. One explanation is that context features are associated with other pieces of information during learning episodes, a binding that is thought to be automatic (e.g., Glenberg, 1997). If those same context features are present at retrieval, a learner is better at remembering the target information.

Despite demonstrating a clear link between memory facilitation and stability of environmental context, past work has at least two major limitations. First, the focus of the literature has been somewhat narrow. For example, the lion's share of research on context-dependent memory has focused on how adults learn lists of words or low level contingencies (e.g., Godden & Baddeley, 1975; S. Smith, 1982). A similar issue exists in the infant literature. The main focus has been on babies learning contingencies between their own actions and a mobile's motion (e.g., Amabile & Rovee-Collier, 1991; Rovee-Collier & Dufault, 1991). Second, a primary focus has been on the potential for context to facilitate rather than disrupt memory. For example, researchers have discovered that memory is best when learning and retrieval contexts match (Amabile & Rovee-Collier, 1991; Cann & Ross, 1989; Finch, Carvalho, & Goldstone, 2016; Godden & Baddeley, 1975; Rovee-Collier & Dufault, 1991; S. Smith & Handy, 2014; S. Smith & Vela, 2001). Research has also revealed that adult memory is improved if participants are given the opportunity to learn in multiple contexts (e.g., S. Smith et al., 1978). The same may be true of short-term memory in infants but perhaps not long-term memory (e.g., Rovee-Collier, 1991). In summary, past work has tended to focus on how memory for certain types of information is facilitated by environmental context.

Past research has made clear that similarities between learning and test environments promotes retrieval of some kinds of information (e.g., lists of words, motion contingencies). Missing from these accounts, however, is whether these context effects emerge during learning of other, more complex pieces of information. Indeed, humans acquire – and regularly use – some types of knowledge that may not fit neatly into existing accounts of context-dependent memory. In particular, humans make heavy use of symbols, an arbitrary link between some referring entity and a referred entity (see DeLoache, 2002 for a review of symbols). Human's symbolic understanding of an entity relies on decontextualization (e.g., DeLoache, 2002; Werner & Kaplan, 1963). For a representation to achieve symbolic status, it requires that a learner generalize beyond an initial learning environment (e.g., Werner & Kaplan, 1963). Said differently, symbols function irrespective of immediate elements of an exposure or retrieval environment (e.g., Bates et al., 1979; Deacon, 1998; Werner & Kaplan, 1963; see Namy & Waxman, 2005 for an alternative account). Decontextualization of symbols suggests that context should not affect acquisition of these kinds of information. If that is the case, past research on context-dependent memory may not fully capture how context affects all types of learning.

Perhaps the most ubiquitous symbols are words. We use words to communicate about entities and ideas we encountered in one environment across many new, unexpected contexts. This means that, in order for communication to flow seamlessly, a learner cannot bind a newly encountered word too closely with an exposure environment. Consider, for example, an individual who has never seen a banjo or heard the word *banjo* until they encounter both at a Dolly Parton concert. It is possible that this learner may bind the word-referent pairing for *banjo* to the concert and the iconic singer on stage. Following a traditional model of context-dependent memory, retrieval of the word *banjo* should be facilitated by environments similar to initial learning (e.g., S. Smith & Vela, 2001). This would mean that the learner would be best at recognizing and retrieving *banjo* from their mental lexicon in contexts that match a Dolly Parton concert. That would make communicating about a banjo less efficient or slower in other contexts, such as a requesting one for purchase in a music store or a casual conversation about instruments in a coffee shop. This is not, however, the way we understand and use words.

Despite the fact that context encoding may occur automatically (e.g., Glenberg, 1997), humans learn decontextualized meanings of words. Memory processes are often considered some of the most basic foundations of learning. It is not clear, however, whether context effects during word learning fit into existing theories of context-dependent memory.

Humans acquire – and generalize – words quite seamlessly from an early age. Even young children can learn the meaning of a novel word and extend it appropriately to new speakers and exemplars (e.g., Behrend, Scofield, Kleinknecht, 2001; Clark, 1990; 2007; Waxman & Booth, 2000). Said differently, children grasp that words are symbols that should be generalized to new contexts. However, it seems that children may acquire this insight gradually over the first two years of life (e.g., Nazzi & Bertoncini, 2003). More specifically, Nazzi and Bertoncini (2003) argue that a shift in how children learn words may explain the vocabulary spurt. By their account, children transition from simply associating sound forms with available referents to generating label-based categories around age 2. Said differently, children come to a "symbolic insight," so to speak, about the referential nature of labels. Coupling this symbolic insight with children's ability to extend words to new speakers and exemplars, it seems likely that children should demonstrate robust word learning regardless of similarities between learning and retrieval contexts. Critically, though, this decontextualized word learning may emerge slowly over time as children gain insight into the symbolic nature of words (e.g., Nazzi & Bertoncini, 2003). Before children understand the decontextualized, referring power of words, they may bind a label-referent pairing with features of an exposure context. This account predicts a period, early in development, when context variability may affect word learning.

While human memory may be bolstered by similarities between learning and retrieval environments, word learning is often defined by a great deal of variability across exposure to unfamiliar words. Indeed, exemplars, speakers, and physical locations are just some of the features that may vary across exposure to a word (see Sandhofer & Schonberg, 2020 for a recent discussion). In general, human memory may benefit from contextual variability across multiple exposure environments. Retrieval in a new testing environment is facilitated by training in multiple environments compared to training in just one environment, a finding true of both adult and infant memory (e.g., Rovee-Collier, 1991; S. Smith et al., 1978). It is not clear, however, whether this facilitative effect extends to word learning. Learning a word involves a great deal of variability that may not be captured by context-dependent memory research. For example, a child learning the word *dog* may, in one exposure, hear her older brother label a Dalmatian walking in the park. During a second exposure, the child may hear her grandmother refer to a chihuahua in a cart at a grocery store. Across just two exposures, the speaker, the referent, and the physical environment varied. It is possible that this degree of variability is difficult to overcome. Across each instance, the child must identity which pieces of information – here, the label *dog* and its referent category – are relevant. Learning in variable contexts may make the task of linking a label and its referent more difficult. If young children do not understand the referring power of words across contexts (e.g., Nazzi & Bertoncini, 2003), they may bind a label to features of an exposure environment. When exposed to the same word in new contexts, the child may initially show difficulty learning the correct meaning.

To summarize, it is not clear whether there are – or even should be – effects of context variability on children's word learning. On the one hand, it seems that word learning should be unaffected by context variability. Indeed, young children recognize that words generalize across speakers of a language (e.g., Clark, 1990, 2007; Diesendruck & Markson, 2001; Henderson & Graham, 2005; Paulus & Wörle, 2019) and across exemplars (e.g., Behrend et al., 2001;

Waxman & Booth, 2000). Said differently, words should be decontextualized symbols (e.g., Werner & Kaplan, 1963). On the other hand, however, young children do not fully comprehend the symbolic nature of words (e.g., Nazzi & Bertoncini, 2003), meaning decontextualization may not occur. Without a sophisticated understanding of words as symbols, children may struggle to identify the relevant elements during exposure to a novel word, leading to difficulty learning words across variable environments.

In recent years, researchers have explored whether children's word learning is affected by context. Importantly, though, this body of research has not sought to explore whether context similarities between exposure and retrieval facilitates learning, which has been a main focus of the context-dependent memory literature (e.g., S. Smith, 2013). Instead, researchers have explored whether context variability disrupts word learning (e.g., Sandhofer & Schonberg, 2020). In word learning research, background contexts are operationalized as either physical backgrounds upon which objects are presented (e.g., Vlach & Sandhofer, 2011; Wojcik, 2017) or the presence of additional objects during exposure to a novel word-referent pairing (e.g., Axelsson & Horst, 2014; Pomper & Saffran, 2018). In this dissertation, I will focus on physical background contexts, and I do so for two reasons. First, these kinds of context have received the most attention in the word learning literature (e.g., Goldenberg & Sandhofer, 2013a; Tippenhauer & Saylor, 2019; Twomey, Ma, & Westermann, 2018; Werchan & Gómez, 2014; Wojcik, 2017; Vlach & Sandhofer, 2011). Second, simple background contexts offer a manageable stand-in for wider environmental contexts, which can be challenging to manipulate with young children in a laboratory setting. Manipulating the variability of localized contexts may provide a first step in understanding how children's word learning is affected by larger environmental contexts, which can be quite complex (e.g., Horst & Simmering, 2015; Medina et al., 2011; Samuelson & McMurray, 2017; Trueswell et al., 2016).

The paradigm that has been used in the background context word learning literature is straightforward. Participants are presented with different exemplars of a novel target category that are labeled by an experimenter. They are also presented with a distractor object that is not labeled. Finally, they are asked to find a new example of a target among a set of different objects, which typically includes a target item and the distractor. Importantly, individual training exemplars, distractor objects, and test arrays are presented on either variable or consistent backgrounds, which serves as the context manipulation. These backgrounds are either physical (e.g., patterned cloths) or electronic (e.g., patterned computer screens). Learning is often compared between variable and consistent training conditions to assess the role context variability may play in label acquisition.

Evidence for context effects during word learning is mixed. In some studies, 2-year-olds exhibit robust word learning regardless of context variability during exposure and recognition test trials (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). This is in line with the possibility that word learning is immune to context effects. On the other hand, there is some evidence that context does affect word learning in the preschool period (e.g., Goldenberg & Sandhofer, 2013a; Twomey et al., 2018; Vlach & Sandhofer, 2011; Werchan & Gómez, 2014). For example, Vlach and Sandhofer (2011) found that 2-year-olds were worse at learning words presented in variable training environments compared to referents presented in consistent ones. Four-year-olds, on the other hand, were adept at learning words regardless of context variability. Werchan and Gómez (2014), in contrast, found that context variability promoted 2-year-olds' label generalization, which is in line with other work on context-dependent memory (e.g., Rovee-Collier, 1991; S.

Smith et al., 1978). These findings suggest that, at least at some point in development, context variability affects word learning.

Although the overall paradigm employed by past work is consistent, there is at least one meaningful difference that may explain divergent findings. Specifically, there were differences in context composition between studies that found evidence for context-dependent word learning and those that did not. Studies that found evidence for context-independent word learning presented novel objects on backgrounds that varied in terms of color or pattern. In these studies, 2-year-olds demonstrated robust word learning regardless of contextual variability between exposures to training exemplars and test trials (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). Work that demonstrated an effect of variable contexts on word learning, on the other hand, presented objects on contexts that were not only defined by color or pattern but also by the presence of familiar, nameable objects (e.g., Twomey et al., 2018; Vlach & Sandhofer, 2011). For example, novel target objects may have been presented on variable contexts that included images of mermaids, followed by contexts that included images of cars, followed by contexts that included images of animals (e.g., Vlach & Sandhofer, 2011; H. Vlach, personal communication, October 17, 2017). Under these conditions, 2-year-olds did not learn words in variable contexts (e.g., Vlach & Sandhofer, 2011). In contrast, separate studies that demonstrated positive effects of context variability on generalization presented unknown objects among consistent familiar competitors. That is, novel objects were displayed on different colored backgrounds, but they were also shown alongside familiar objects that repeated across exposure trials (e.g., Twomey et al., 2018).

It is possible that differences in context composition account for divergent findings in context-dependent word learning research. In particular, it seems that backgrounds that include nameable objects or entities disrupt word learning more than backgrounds that do not. The additional items may act as competitor referents, resulting in less robust word learning, perhaps because children attend to the distractor items during label training instead of the referent items. Indeed, there is research demonstrating the effects of co-present competitor referents on label learning generally. When novel objects are presented with the same set of familiar, nameable competitors across training instances, 3-year-olds can successfully learn novel labels, but they have difficulty learning words if familiar competitors vary across trials (Axelsson & Horst, 2014). Additionally, 2-year-olds are unable to retain words for novel referents presented among 3 or more familiar competitors (Horst, Scott, & Pollard, 2010). Interestingly, the relative salience of a single familiar competitor can affect learning. In particular, 3-year-olds show lower retention of label-referent mappings when a novel object is presented with a salient, familiar competitor than when the novel object is in the presence of a less salient, familiar competitor (Pomper & Saffran, 2018). If this account is accurate, backgrounds containing competitor familiar referents may disrupt word learning more than background contexts that do not contain possible competitors.

An important question remains: Why might the composition of background contexts influence the emergence of context effects on word learning? One possibility is that contexts containing nameable objects are more conceptually complex, and therefore more interesting or distracting, than contexts that do not contain recognizable items. This explanation fits neatly into existing theories of context-dependent memory. In particular, research with adults suggests that context encoding is an automatic process that must be actively suppressed (e.g., Glenberg, 1997; S. Smith & Vela, 2001). As a result, context will affect memory if a learner is unable to suppress irrelevant context features during learning and retrieval (e.g., Matzel, Schachtman, & Miller, 1985; S. Smith & Vela, 2001). Background contexts that contain nameable objects or entities may draw young children's attention more than contexts that do not contain recognizable objects. This would mean that children have fewer cognitive resources available to dedicate to encoding and remembering relevant labeling-referent pairings. Perhaps unsurprisingly, research has demonstrated that children who attend more to background contexts during label exposure attend less to target items at test (Goldenberg & Johnson, 2015). It is quite plausible, then, that background composition may moderate the size of context's effect on word learning. This analysis raises the possibility that context effects in word learning may be most likely to emerge under certain conditions, namely when context features interfere with the encoding of pairings between labels and referents. Contexts containing nameable objects may be more likely to disrupt this encoding process than contexts without nameable objects.

Younger children may be more affected by salient context features than older children. This could be the case for at least two related reasons. First, a symbolic understanding of words emerges gradually, and children may gain this particular insight during the second year of life (e.g., Nazzi & Bertoncini, 2003). Because of this developmental trajectory, younger children may have a more difficult time recognizing which features of an exposure environment are relevant to word learning. Younger children, who are beginning to grasp words as symbols, may inappropriately bind contextual information to a newly-encountered word. Second, young children, who are still developing inhibitory control (e.g., Harnishfeger & Bjorklund, 1994), may be more likely to struggle with context suppression. These two factors may combine, leading to children's difficulty ignoring salient context features and increasing the likelihood of context-dependent word learning. There is indirect evidence for this potential developmental trajectory. In one study, 3- and 4-year-olds were able to learn novel words for objects presented on background contexts that contain variable competitor items. Two-year-olds, on the other hand, were not able to learn words under these conditions (Vlach & Sandhofer, 2011). Early in development, word learning may be affected by more complex contexts because young children do not fully recognize the symbolic nature of labels and have a harder time suppressing irrelevant features. I focus on 2-year-olds in this dissertation because they are the age group that has most consistently demonstrated context effects during word learning (e.g., Axelsson & Horst, 2014; Goldenberg & Sandhofer, 2013b; Vlach & Sandhofer, 2011).

Experiment 1 investigates the role of background context composition on 2-year-olds' word learning. In particular, this experiment investigates whether more complex backgrounds (that include nameable objects in a perceptually cluttered scene) disrupt word learning more than less complex backgrounds. Experiment 2 investigates whether context effects in Experiment 1 were due to the composition of backgrounds or to the fact that children had more difficulty parsing target objects from complex backgrounds than from less complex backgrounds. Together, the results of these two experiments provide a first step in characterizing when context is most likely to affect children's word learning. More specifically, this dissertation offers an initial account of whether more complex backgrounds disrupt word learning more than less complex backgrounds.

CHAPTER 2

Experiment 1

Past work provides contradictory evidence for the effects of background context variability on word learning. In the context-dependent word learning literature, the most common paradigm involves presenting novel objects on colored or patterned cloths or computer screens, which serve as background contexts. Using this method, researchers have found that differences between learning and test contexts disrupts 2-year-olds' immediate word learning. Four-year-olds, in contrast, learn words equally well regardless of differences or similarities between contexts during label training and test trials (Vlach & Sandhofer, 2011; see Finch, Carvalho, & Goldstone, 2016 for a similar study with adults). Additional work suggests that 2-year-old children are capable of learning words in variable contexts but only if those contexts are interleaved with consistent ones (Goldenberg & Sandhofer, 2013a). However, there is evidence that, under some circumstances, 2-year-old's immediate word learning may not be affected by context variability (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). In addition, longer retention of labels may benefit from variability in contexts during learning (Werchan & Gómez, 2014), but other work has found no effect of context variability on retention (Wojcik, 2017). Differences in the composition of the backgrounds used in past work may explain the divergent results.

Experiment 1 tested whether more context composition affects the emergence of context effects in 2-year-olds' word learning. Participants were presented with novel labels and referents in two types of contexts: non-nameable and nameable. Non-nameable contexts were cloths that were plain colors or patterns (e.g., polka dotted, checkered, striped, etc.). Nameable contexts were cloths that included images of familiar, nameable entities (e.g., cats, airplanes, horses, etc.).

I predicted that children would learn fewer words when targets were presented against variable, nameable background contexts. A between-subjects delay phase was included to test label retention. The immediate and delay phases were included to offer insight into how context composition affected children's performance. If context composition simply affected attention in the moment, children should demonstrate lower target selection on immediate trials for Nameable trials than Non-nameable trials, but their delayed scores should be comparable. If, on the other hand, children are encoding some information about contexts, they should perform worse on Nameable trials both immediately and after a delay. Preregistration information can be accessed here: https://osf.io/qupby.

Method

Participants

Twenty-four 2-year-olds participated (*M* = 2 years, 6 months; *SD* = 2 months; age range: 2 years, 2 months, 7 days – 2 years, 10 months, 30 days; 12 male, 12 female). This sample size was selected based on a power analysis using Tippenhauer and Saylor's (2019) smallest reported significant effect. This sample size grants over 80% power to detect similarly sized effects. Two additional children were recruited, but their data were excluded due to caregiver interference during the experiment. Caregivers reported children heard primarily English at home and school. Participants were recruited from a database using public birth records from a large city in the southeastern United States. Children received a toy or book as compensation for participating.

Materials

Novel objects were constructed from items purchased at hardware and craft stores (see Figure 1 for examples). Two types of novel objects were placed in yoked pairs. Within each pair, one object served as the target and the other as the distractor (see Figure 1). Which object in each yoked pair served which role was counterbalanced across participants. For each target object, there were three unique learning exemplars that differed from one another based on color (see Figure 1). Distractor objects were identical during training and at test. Novel labels were assigned to each yoked pair.

Figure 1. One combination of training, distractor, and test phases. The top row depicts a non-nameable trial, and the bottom row depicts a nameable trial. The delay phase is not depicted for simplicity.

Objects were wrapped in patterned cloths. In the nameable condition, learning phases occurred on patterned cloths that included images of potential competitor referents (e.g., dogs, airplanes, cats, etc.). In the non-nameable condition, each learning phase and test phase occurred on a different patterned cloth that did not include images of potential competitor referents (e.g., polka dot, striped, camouflage, etc.). Figure 1 depicts examples of each type of background. With objects at the center, cloths were turned inside out and held together with a piece of twine to give the appearance of a sack. To present the objects, the twine was removed, and the cloth was unwrapped. This resulted in objects sitting on top of the cloth. Cloth pieces were purchased at a craft store and were large enough (18 X 21 inches) to conceal objects.

Design

Context composition was defined by the pattern of cloth upon which objects were presented. Participants completed three immediate trials in the nameable context and three immediate trials in the non-nameable context, resulting in immediate nameable and non-nameable blocks. Salience presentation order was counterbalanced across participants. Participants also completed three delayed trials that matched the context condition of their second immediate block. For example, a child may have completed three immediate nameable trials followed by three immediate non-nameable trials before getting a 10-minute break followed by 3 non-nameable delay trials. This reduction in trial quantity between immediate and delay portions of the experiment was done to reduce participant fatigue. Immediate context composition was a within-subjects manipulation whereas delayed context composition was a between-subjects manipulation.

Procedure

Caregivers were instructed to not provide any feedback to their child during the experiment. Children were told they were going to play a game with new toys. Participants completed six immediate trials and three delay trials. Each immediate trial consisted of training, distractor, and test phase. Delay trials only included a test phase. All delay trials occurred in a block following the 10-minute delay. Sessions were videotaped.

During training, participants were presented with three instances of a novel object in succession. Objects, wrapped in cloth, were initially hidden from view. At the beginning of each training exposure, the object was brought out concealed in a bundle of cloth. Each exemplar was presented on a different patterned cloth. Once unwrapped, objects were labeled twice (e.g., “This is a *modi*. Do you see the *modi*?”). The child was invited to play with the object. Then, the object was wrapped back up and placed out of view. This sequence was repeated three times for each set of objects (i.e., for all three exemplars of the target object in a yoked pair).

Next, distractor objects were presented on a cloth, the pattern of which was determined by condition. The distractor object was not labeled, but the experimenter did draw the participant's attention to it using two utterances of enthusiastic, child-directed speech (e.g., "Look at this one! Do you see it?"). At the end of the distractor phase, the object was wrapped up and placed out of participants' view. For half of the participants, the distractor phases began immediately after training phases. For the other half, the distractor phases preceded the training phases. This was done to control for potential recency or primacy effects in item selection at test. Figure 1 depicts examples of distractor and test phases.

Before each immediate test trial, the experimenter prompted the participant with a request for help looking for an item (e.g., "We're going to look for a *modi.* Can you help me find it?"). Then, children were presented with a set of four objects. The four objects included the distractor, a novel member of the target category, a familiar object, and an unfamiliar novel object (see Figure 1). Once the objects were unwrapped, the experimenter asked the child to select the target object using the novel label taught during training (e.g., "Can you point to the *modi*?"). Requests were only made twice, once before objects were unwrapped and once after. Immediate test phases concluded once the participant made a clear selection (e.g., pointed to or picked up one object). In the event that a child selected multiple items, the experimenter reminded the child to only pick one.

After the participant completed the last of the six immediate trials, the experimenter and child read books or played with puzzles for 10 minutes in the experiment room. Then, the participant completed the delay test trials. Delay test trials occurred in the same order and on the same cloths as the second block of immediate trials. Delay trials did not include training or distractor phases. For example, if a child's second block included the words modi, toma, and wug in the non-nameable context condition, the delay trials followed that order on the same non-nameable cloths. Delay test trials followed the same script as immediate test trials.

Coding

Participants' responses to requests at test were recorded in real time by the experimenter and offline by a naïve coder. Interrater reliability between experimenter and naïve coder was 90% for the 88% (21 of 24) of available videotaped sessions. For the 7 trials where disagreement occurred, the naïve coder's judgement was used.

For each immediate or delay test phase, participants were given a score of 1 if they pointed to, grabbed, or handed the experimenter the target object and a 0 if they selected any other object or if they selected more than one object.[1] The maximum score for the immediate test phases was 6, but this was split into a score out of three for each of the two immediate context conditions. The maximum score for the delay test phase was 3. Raw scores were converted to proportions for consistency across phases.

Results

The key dependent measure was proportion of target selection across Context and Phase. To compare children's performance during the immediate phase, a 2 (Context: Nameable vs. Non-Nameable) X 2 (Order: Nameable First vs. Non-Nameable First) mixed-effects ANOVA was conducted. There was a main effect of Context, $F(1, 22)=5.11$, $p=.03$, $\boldsymbol{\eta}_p^2=.19$. Children selected targets more on Non-Nameable trials ($M=0.57$, $SD=0.40$) than Nameable trials ($M=0.40$, $SD=0.41$). There was no main effect of Order ($F(1, 22)=1.30$, $p=.27$, $\boldsymbol{\eta}_p^2=.06$) nor was there a

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[1] I also scored instances where children picked two items based on the selection they made when the experimenter asked them to pick just one. This did not change the results.

significant interaction between Context and Order (*F*(1, 22)=0.14, *p*=.71, $\boldsymbol{\eta}_{\mathrm{p}}^{2}$=.01). Responding for the children who received Non-Nameable trials first and Nameable trials second (*M*=0.40, *SD*=0.42) was statistically no different than children who were tested in the opposite order (*M*=0.57, *SD*=0.39). This suggests that the order of context presentation did not have an effect on target selection.

Two-tailed, one sample t-tests against chance (0.25) were used to determine whether children were systematically selecting the target in either context condition on the immediate test trials. These tests revealed that children selected targets above chance levels for Non-Nameable trials, *t*(23)=3.92, *p*<.0001, and marginally above chance levels for Nameable trials, *t*(23)=1.85, *p*=.08. Immediate target selection rates are depicted in Figure 2.

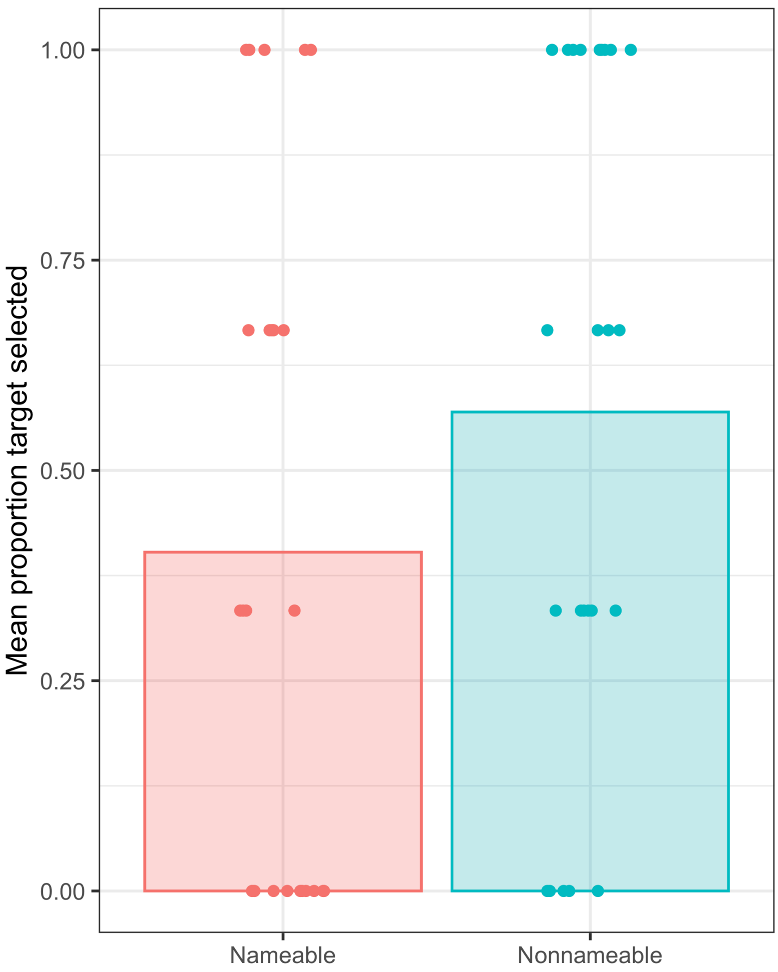

Figure 2. Mean proportion of target selections for immediate trials (composite of Immediate Blocks 1 and 2) in Experiment 1. Delay data is not presented here. Individual participants' responses are depicted as individual data points.

A 2 (Context: Nameable vs. Non-Nameable) X 2 (Phase: Immediate vs. Delay) mixed-effects ANOVA was conducted with Context as a between-subjects and Phase as a within-subjects factor to test performance over time. The Immediate Phase only included data from children's second block of trials, which is the one that matched their Delay Phase condition. There was no significant main effect of Context ($F(1, 22)=2.23$, $p=.15$, $\eta_p^2=.09$); performance on

Nameable trials (*M*=0.36, *SD*=0.38) and Non-Nameable trials (*M*=0.57, *SD*=0.39) did not reliably differ. There was no main effect of Phase (*F*(1, 22)=0.93, *p*=.34, η_{p}^{2}=.04); overall immediate performance (*M*=0.50, *SD*=0.41) was not significantly different than overall delay performance (*M*=0.43, *SD*=0.39). However, was there a marginal interaction between Context and Phase, *F*(1, 22)=3.02, *p*=.096, η_{p}^{2}=.12. This interaction was due to a marginal decrease in target selection on Non-Nameable trials between immediate (*M*=0.67, *SD*=.35) and delay (*M*=0.47, *SD*=0.41) phases, *t*(11)=-1.74, *p*=.06, *d*=0.5. There was no change in target selection on Nameable trials between immediate (M=0.33, SD=0.41) and delay (*M*=0.39, *SD*=0.37) phases, t(11)=0.62, *p*=.55, *d*=0.1.

Finally, one-sample t-tests were conducted to compare delay target selection against chance (0.25) on delay trials. Children's target selection rate was marginally above chance for Non-Nameable trials, *t*(11)=1.89, *p*=.09. Children's target selection was at chance for Nameable trails (*t*(11)=1.29, *p*=.22).

Discussion

Results of Experiment 1 provide evidence that context composition affects 2-year-olds' word learning. Children selected targets above chance after training for non-nameable context trials. Children also demonstrated less accurate referent selection when they were exposed to labeled exemplars on backgrounds that contained nameable distractors than when exemplars appeared on backgrounds that were solid patterns or colors. The effect of context composition was only present immediately.

From the results of Experiment 1, it seems that context may affect young children's word learning (e.g., Goldenberg & Sandhofer, 2013a; Vlach & Sandhofer, 2011; Werchan & Gómez, 2014). However, Experiment 1 qualifies this possibility in a crucial way. Namely, the results demonstrate that some contexts are more likely to influence word learning than other contexts. More specifically, it seems that variable contexts containing nameable objects influence word learning whereas variable contexts without nameable objects do not. This distinction is one potential explanation for diverging accounts of context-dependent word learning in the literature. Research that has demonstrated context-dependent word learning has presented target objects on contexts that included other potential referents, which may have made the contexts more salient (e.g., Twomey et al., 2017; Vlach & Sandhofer, 2011). This finding has not been replicated using contexts that do not include namable items (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). It seems, then, that context effects on word learning are somewhat context dependent themselves.

There are several possible reasons why differences in context composition may matter during word learning. One likely explanation is that including additional objects in backgrounds makes a word learning task more ambiguous, resulting in less certainty about a novel word's referent. Children can disambiguate a novel word in the presence of one familiar distractor (mutual exclusivity; e.g., Markman & Wachtel, 1988; Merriman, Bowman, & MacWhinney, 1989). In the presence of multiple distractors, however, young preschoolers struggle to learn the meaning of a novel word (e.g., Axelsson & Horst, 2014; Horst et al., 2010). This could be because of referential ambiguity, or it could be because children attend to distractor objects and do not encode novel word-referent pairings.

It is also possible that contexts including nameable objects are more salient and distracting and, therefore, more likely to be attended to. Indeed, context encoding is thought to happen automatically and must be suppressed to avoid context-dependent learning (e.g., Glenberg, 1997). In addition, young children are still developing their ability to both suppress irrelevant information (e.g., Harnishfeger & Bjorklund, 1994) and identify which factors are irrelevant during word learning (e.g., Nazzi & Bertoncini, 2003). Perhaps contexts that include nameable objects are more difficult to suppress. It may, therefore, require additional cognitive resources to suppress salient or distracting contexts. If that is the case, children may have fewer cognitive resources available to attend to relevant label-referent information. Said differently, attending more to salient contexts could increase context dependences in children's word learning (e.g., Goldenberg & Johnson, 2015; S. Smith & Vela, 2001). However, the results of Experiment 1 only support this possibility for immediate target selection. Because the condition differences in Experiment 1 only appeared immediately, it could be the case that context composition affected attention and not longer-term retention. Other work demonstrating that context variability disrupts word learning also focused on immediate target selection (e.g., Vlach & Sandhofer, 2011), providing additional support for the possibility that attention, not memory, is the driving force behind these effects. Future work should investigate these possibilities by incorporating longer delays between training and test trials.

There is, however, at least one competing possibility: The effects of Experiment 1 could be due to children's difficulty separating relevant target items from more complex backgrounds. In other words, perhaps children had a more difficult time segmenting objects from the backgrounds that contained nameable objects than the backgrounds that did not. If children are not able to identify a target item at all, it is unlikely they will learn a label for it. To better understand why context composition is affecting learning, object segmentation must be addressed directly. Experiment 2 explores the potential role of object segmentation in the results of Experiment 1.

CHAPTER 3

Experiment 2

Object segmentation, the ability to distinguish between two discrete items or entities, is a skill that emerges in early infancy. As infants age, they become more adept at recognizing the boundaries of one object in relation to another (e.g., Needham, 1999; 2000). There is less information in the literature, however, about how older children parse objects from complex visual fields. It is possible that 2-year-olds may struggle to parse a single item from a salient, complex background. If that is the case, it is not clear what drove the results of Experiment 1. That is, it is unclear whether 2-year-olds struggled because of the presence of additional objects that made naming episodes more difficult or if children simply were unable to parse target items from complex backgrounds. Experiment 2 investigates whether failure to segment target objects can explain the context effects revealed in Experiment 1. In this experiment, participants were taught words in variable, complex contexts (e.g., those that include other nameable things). In one condition, objects were segmented from the background for children using common motion (e.g., Kellman & Spelke, 1983). In the other condition, objects were not segmented.

If the effects of Experiment 1 were due to 2-year-olds' inability to segment target items from complex backgrounds, participants in the segmentation condition should demonstrate more robust word learning than children in the no segmentation condition. If, on the other hand, object segmentation is not the driving force in Experiment 1, participants should demonstrate difficulty learning words in both conditions, comparable to the Nameable condition in Experiment 1. This study was preregistered and can be accessed here: https://osf.io/mxbr4.

Method

Participants

A new group of twenty-four 2.5-year-olds were recruited for this experiment (*M*=2 year, 6 month, 15 days, *SD*=2 months, 24 days; age range: 2 years, 1 month, 28 days – 2 years, 11 months, 19 days; 12 male, 12 female). This sample grants over 80% power to detect effects similar in size to those reported by Tippenhauer and Saylor (2019). Caregivers of eligible children were contacted using a database comprised of both public birth records and interested families as in Experiment 1.

Materials

All materials were identical to those used in Experiment 1 (see Figure 1). However, in this experiment only cloths that depicted nameable items were used.

Design

Participants were randomly assigned to one of two conditions: Segmentation or No Segmentation. Participants completed 4 total trials, which included learning, distractor, test, delay, and delayed test phases. Participants completed all 4 trials' learning, distractor, and test phases before a 10-minute delay. After the delay, participants completed the 4 delayed test phases. This is different from Experiment 1 which included 6 immediate trials and 3 delay trials per child.

Procedure

The procedure was similar to Experient 1 with one critical difference: In the Segmentation condition, after unwrapping individual training and distractor items, the experimenter lifted the object slightly above the cloth and move it a few inches to the left and a few inches to the right. Then, the experimenter placed the object back on the cloth and labeled it (e.g., “Look at this *modi.* Do you see the *modi*?”) or reference it for distractors (e.g., “Look at this one! Do you want to play with it?”). In the No Segmentation condition, the experimenter unwrapped the object then grasped it for approximately 2-3 seconds. After that, they would release the object and label it.

Coding

Coding was identical to Experiment 1.

Results

Children’s responses on test and delayed test trials were analyzed using a 2 (Condition: Segmentation vs. No Segmentation) X 2 (Time: Immediate vs. Delay) mixed effects ANOVA. Time was a within-subjects factor. This analysis revealed no significant main effects of Condition ($F(1, 22)=0.27$, $p=.61$) or Time ($F(1, 22)=2.11$, $p=.16$). There was also no significant interaction between the two, $F(1, 22)=0.23$, $p=.63$. This suggests that there was no difference in children’s target selection across conditions or time. There was no statistical difference between target selection in the No Segmentation and Segmentation conditions.

To confirm this result, JZS Bayes factors *t*-tests were conducted (e.g., Kruschke, 2013). JZS Bayes factors estimate the relative probability of observed data under one model, the null hypothesis, compared to another model, the alternative hypothesis. The magnitude of a JZS Bayes factor indicates the strength of support for a particular hypothesis. For example, a JZS_{ALT} value of 3 would mean that the alternative hypothesis is 3 times more likely than the null. A JZS_{NULL} value of 2, on the other hand, would mean that the null hypothesis is twice as likely as the alternative hypothesis. These analyses revealed evidence to support the hypothesis that there was no difference between Segmentation and No Segmentation conditions before or after a delay. For immediate trials, target selection for in the No Segmentation condition *(*$M=0.38$*,* *SD*=0.25) did not statistically differ from target selection in the Segmentation condition (*M*=0.46, *SD*=0.32), *t*(22)=0.72, *p*=.48, JZS_{NULL}=2.22. For delay trials, target selection in the No Segmentation condition *(M*=0.50*, SD*=0.28) did not statistically differ from target selection in the Segmentation condition (*M*=0.52, *SD*=0.31), *t*(22)=0.17, *p*=.86, JZS_{NULL}=2.65.

I also compared children's target selection proportion across conditions and time to chance (chance=0.25). In the No Segmentation condition, children selected targets at chance immediately (*M*=0.38, *SD*=0.25, *t*(11)=1.73, *p*=.11) but above chance after a delay (*M*=0.50, *SD*=0.28, *t*(11)=3.07, *p*=.01). In the Segmentation condition, children selected targets above chance immediately (*M*=0.46, *SD*=0.32, *t*(11)=2.28, *p*=.04) and above chance after a delay (*M*=0.52, *SD*=0.31, *t*(11)=3.03, *p*=.01). Results are depicted in Figure 3.

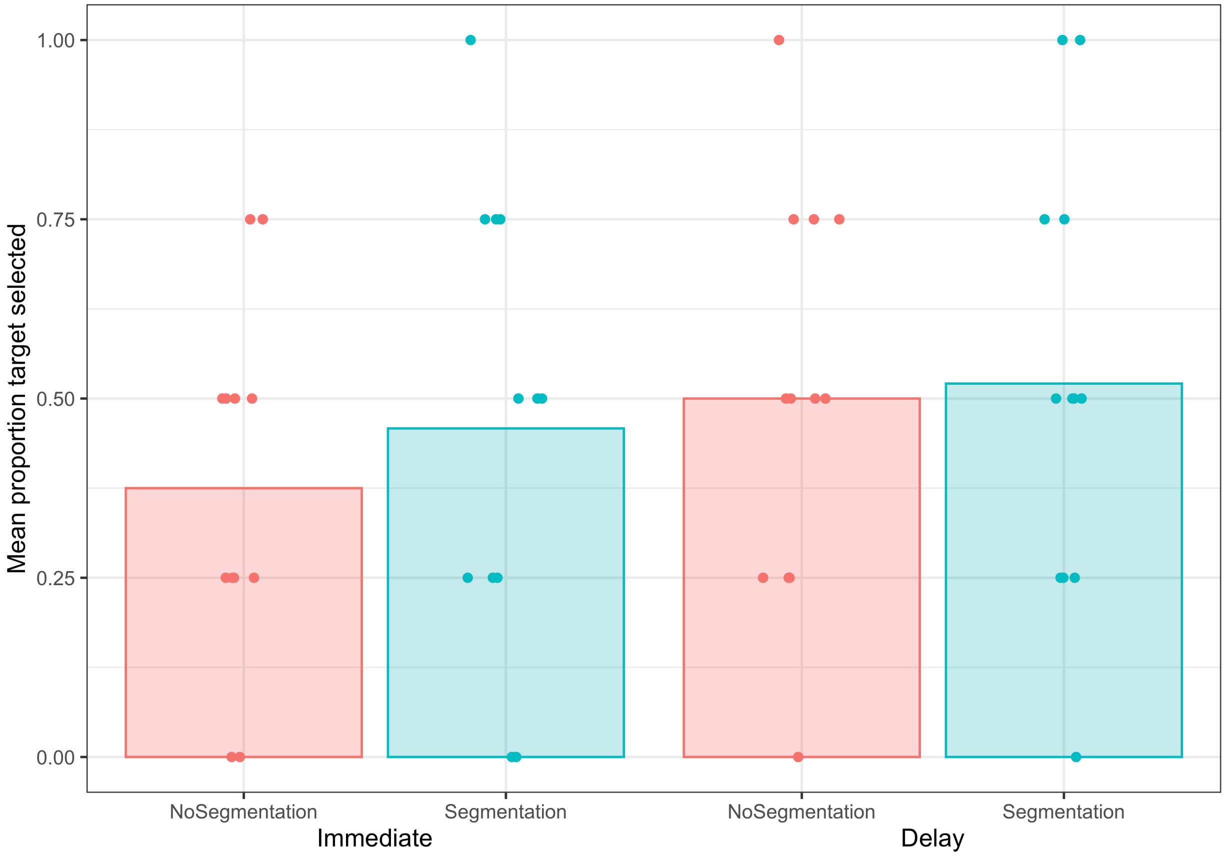

Figure 3. Mean proportion of target selections across conditions and phase in Experiment 2. Individual participants' responses are depicted as individual data points.

As an exploratory analysis, I compared target selection in both conditions of Experiment 2 to performance in the Nameable condition of Experiment 1. For these analyses, I conducted two separate one-way ANOVAs for immediate and delay data. Condition (Segmentation, No Segmentation, and Nameable) was the between-subjects factor. For immediate target selection, there was no effect of condition, *F*(2, 45)=0.18, *p*=.84. For delay target selection, there was also no effect of condition, *F*(2, 33)=0.58, *p*=.57. This suggests that segmenting objects did not provide a boost in performance compared to simply presenting objects on cluttered backgrounds (the Nameable condition in Experiment 1). I also conducted additional JZS Bayes factor *t*-tests to confirm the results of the ANOVAs. For immediate trials, target selection in the No Segmentation condition did not statistically differ from target selection in the Experiment 1 Nameable condition, *t*(34)=0.22, *p*=.83, JZS_{NULL}=2.92. There was also no statistical difference in target selection immediately between the Segmentation condition and the Experiment 1 Nameable condition, *t*(34)=0.41, *p*=.68, JZS_{NULL}=2.78. For delay trials, target selection in the No Segmentation condition did not statistically differ from target selection in the Experiment 1 Nameable condition, *t*(22)=0.82, *p*=.42, JZS_{NULL}=2.09. There was no statistical difference in target selection after a delay between the Segmentation condition and the Experiment 1 Nameable condition, *t*(22)=0.94, *p*=.35, JZS_{NULL}=1.94.

Discussion

The purpose of Experiment 2 was to explore the role of object segmentation in the emergence of context-dependent word learning in Experiment 1. It could be the case that context effects are driven by children's inability to segment target objects from messy perceptual backgrounds. The results of Experiment 2 offer mixed evidence for the role of object segmentation in context-dependent word learning. I predicted that children would show comparable rates of target selection regardless of whether objects were segmented for them or not. The results support this prediction. However, an unexpected difference emerged between conditions: Children selected targets above chance when objects were segmented for them and at chance when objects were not segmented. This suggests that object segmentation may have some effect on context-dependent word learning.

The results of Experiment 2 offer new insight into how context may affect word learning. More specifically, the results suggest that low-level perceptual abilities (i.e., object segmentation) could be at play in context-dependent word learning. Children learned words above chance when targets were segmented using common motion. They selected words at chance when objects were simply grasped. Even though young infants can segment objects from one another (e.g., Needham, 1999; 2000), 2-year-olds still seemed to benefit from having target objects segmented from complex backgrounds. It could be the case that children's segmentation skills are still developing over the first few years of life. Thus, the situation children faced in Experiment 2 could have been difficult for them; it may have been challenging to identify target objects presented on perceptually chaotic backgrounds. Difficulty segmenting the targets from the backgrounds could have led to lower rates of target selection. When considering the messy environments children face in their everyday lives (e.g., Medina et al., 2011; Trueswell et al., 2016), it becomes even more apparent the central role that object segmentation could play in word learning. If children unable to identify a labeled target from a chaotic scene, they will likely not learn the link between a word and its referent. Future work should continue to investigate the role of object segmentation in context-dependent word learning.

Importantly, the results of Experiment 2 cannot directly rule out the possibility that merely touching an object decreases the likelihood of context effects during word learning. In both conditions, the experimenter touched the objects, either to grasp it (the no segmentation condition) or to move it (the segmentation condition). Perhaps touching the object helped children identify that it was relevant. This could explain why there was no difference in rates of target selection between the two conditions. However, cross-experiment analyses suggest this may not be the case. There was no statistical difference in target selection between the nameable condition of Experiment 1 and the no segmentation condition of Experiment 2. Importantly, these two conditions differed only in whether the experimenter touched target objects or not. Nevertheless, additional research should more directly address whether mere contact with an object makes it more salient during word learning.

The results of Experiment 2 do not unequivocally point to object segmentation as the sole driving force behind context-dependent word learning. Indeed, there was no difference between the Segmentation and No Segmentation Conditions. In fact, Bayesian analyses revealed stronger support for no difference between conditions than a difference between them. Moreover, exploratory analyses revealed no difference between the No Segmentation and Segmentation conditions in Experiment 2 and the Nameable condition in Experiment 1. This comparison offers additional evidence that object segmentation is not the primary force driving context-dependent word learning. This implies that other factors are influencing the emergence of context effects during word learning. Future research should work to identify all factors that contribute to the emergence of context effects during early word learning.

CHAPTER 4

General Discussion

This dissertation explored one reason why context effects may emerge during word learning. Specifically, I investigated whether more complex background contexts disrupt 2-year-olds' word learning more than less complex background contexts. Here, context complexity was operationalized as the inclusion of nameable objects in backgrounds. Experiment 1 compared 2-year-olds' word learning in complex contexts that contained nameable things and less complex contexts that did not. Word learning was worse in more complex contexts but only immediately after training and not after a 10-minute delay. Experiment 2 explored the role of object segmentation in explaining the difficulty children had learning words for objects presented among nameable competitors. Results of Experiment 2 suggest object segmentation could play a small role in context-dependent word learning.

Experiment 1 provides evidence that background context composition matters during word learning. In Experiment 1, 2-year-olds struggled to immediately identify a new word's referent if trained in variable contexts that included familiar nameable items. These same children can, however, immediately identify a word's referent if exposed to label-referent pairings in contexts that do not contain nameable objects. The results from Experiment 1 provide partial support for the idea that more complex backgrounds (e.g., those that include nameable objects) disrupt word learning more than less complex backgrounds. This possibility is in line with work that has found that preschoolers struggle to learn words for novel objects that are presented alongside multiple familiar competitors (e.g., Axelsson & Horst, 2014; Horst et al., 2010; Pomper & Saffran, 2018). Additional work suggests that children's real-world environments are perceptually cluttered and characterized by the presence of numerous irrelevant objects (e.g., Medina et al., 2011; Trueswell et al., 2016). The results of Experiment 1 suggest that variability of these chaotic environments could disrupt young children's word learning. It is important to note, however, that these condition differences in Experiment 1 were less robust after a brief delay. More specifically, the difference between conditions decreased following a 10-minute delay and no longer reached statistical significance. More complex contexts may affect immediate identification of targets, but it is not clear whether these effects extend to label retention. Future work should explore the link between context composition and longer term of word meanings.

Results of this dissertation provide one plausible explanation for the conflicting accounts of context-dependent word learning in the literature. In particular, this dissertation addresses whether differences in methods (i.e., inclusion of nameable objects in background contexts) led to differences in results between past investigations of context-dependent word learning. Studies that used contexts with nameable objects (e.g., Twomey et al., 2018; Vlach & Sandhofer, 2011) found evidence for context-dependent word learning while studies that used more basic contexts did not (e.g., Tippenhauer & Saylor, 2019; Wojcik, 2017). The results of the present experiments suggest that this difference across studies, the presence of absence of nameable competitors in backgrounds, may partially explain divergent findings. Variable contexts that include nameable objects affect 2-year-olds' word learning differently than contexts that do not. This is a critical insight for the context-dependent word learning literature, which had demonstrated a confusing pattern of contradictory results.

There are a number of possible explanations for why word learning may be disrupted by variable backgrounds containing nameable entities. One possible is that those entities draw attention and increase ambiguity. Said differently, competitor items may affect children's word learning in two ways: by distracting children and by increasing referential ambiguity. In line with this account is work demonstrating that children's disambiguation skills develop during the second year of life (e.g., Bion, Borovsky, & Fernald, 2013). In Bion and colleagues' (2013) experiment, 18-month-olds did not distinguish between a novel and familiar object when hearing a new word. By 30 months, children correctly identified the novel object when hearing a new word, but they did not show evidence of longer term retention. It seems that, at least early in development, children may struggle to rapidly identify the correct referent of a novel word in ambiguous situations. Difficulty disambiguating a novel referent during naming is directly relevant to the results of Experiment 1. In Experiment 1, children were presented with novel objects in variable contexts that contained other nameable entities. 2-year-olds may have struggled to identify the intended referent of novel words across exposures. Disambiguation difficulty could explain the difference between conditions in Experiment 1.

Of course, it is possible that some contexts (e.g., those containing nameable objects) affect word learning more because they are more perceptually complex. This complexity could make object segmentation more challenging, because there are more perceptual features for young children to ignore when segmenting relevant visual information. More specifically, children may have a hard time ignoring co-present competitor objects, which are irrelevant to word learning, and focusing on the relevant target object. The results of Experiment 1 alone cannot rule out this perceptual account. The results of Experiments 2, however, address this possibility. Experiment 2 provides somewhat ambiguous evidence for the role of object segmentation difficulty in context-dependent word learning. It seems that, when presented with novel objects on backgrounds that contain other nameable items, children benefit from having the unfamiliar objects highlighted through motion. This may have made segmentation easier for the children. If this is the case, it would suggest that object segmentation may be relevant in explaining context-dependent word learning.

However, Experiments 1 and 2 do not clarify the exact cause of word learning difficulty across variable complex contexts. On the one hand, the difficulty could be due to conceptual factors, such as referential ambiguity. On the other hand, word learning difficulty could be due to more perceptual factors, such as object segmentation. To adequately disentangle these possibilities, an experiment would need to be conducted that preserves perceptual complexity but removes nameability of objects in backgrounds. Experiment 1 did not control for perceptual complexity across the nameable and non-nameable conditions. In that experiment, contexts varied across condition in terms of both the presence of nameable items as well as perceptual complexity. Backgrounds that did not contain nameable items were simple patterns or solid colors. Contexts with nameable items were comprised of items that were more perceptually complex and added visual clutter. To better control for the perceptual differences between conditions, individual items of a background (e.g., vehicles, animals, fruits) could be isolated and then edited individually so they are no longer recognizable. The manipulated images could then be used to generate backgrounds that retained features like spatial frequency, a practice common in the vision literature (e.g., Stojanoski & Cusak, 2014). Doing this would allow for consistent levels of perceptual complexity across backgrounds, therefore isolating the role of nameable competitors on novel word learning. If the nameability of objects produces context effects, children will learn fewer words in the original contexts than in the edited ones. Future research should test this prediction.[2]

While this dissertation addresses the role of context composition during word learning, the results do not explain the mechanisms underlying this relationship. Although there are a number of possible explanations, one in particular is worthy of investigating further: context suppression. Human memory is thought to automatically incorporate features of exposure environments (e.g., Glenberg, 1997). In order to minimize the link between target information and ambient context, a learner must suppress the irrelevant contextual information during learning and retrieval (e.g., S. Smith & Vela, 2001). It is likely that this is case with young children as well. Indeed, infants who attend to context more during learning tend to show greater context-dependent word learning than infants who do not (Goldenberg & Johnson, 2015). Moreover, young children are still developing inhibitory control (e.g., Harnishfeger & Bjorklund, 1994), meaning they may not yet possess the skills necessary to ignore irrelevant features. Perhaps contexts that include additional objects are more likely to draw attention, more difficult to suppress, and, therefore, encoded more often.

If more salient contexts are more likely to be encoded, there should be enduring effects of salient contexts on memory. Results of Experiment 1 suggest that more complex contexts disrupt target selection immediately but not after a delay. This could be because children’s attention is drawn toward the backgrounds during initial exposure, which makes immediately identifying a novel word’s referent challenging. However, it is not clear whether children are encoding information about the contexts. Said differently, it is not clear whether more salient and less salient contexts differentially affect longer-term retention of label information.

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[2] This was originally going to be the third experiment of my dissertation. However, the COVID-19 pandemic prevented me from designing study materials and collecting data from 2-year-olds.

The fact that condition differences disappear in Experiment 1 after a brief delay may suggest that children are forgetting information about background contexts. Over even longer delays, children may experience increased forgetting, leading to consolidation of memories for labeling episodes. Through the consolidation process, children's memory traces may include only relevant information, the label and its referent, and not information about ambient context features (e.g., Werchan & Gómez, 2014). This account predicts that context variability does not affect longer-term retention of words. Other work, however, suggests that the co-presence of consistent, familiar objects facilitates longer-term retention of novel word-object pairings (Twomey et al., 2017). Future work could explore how longer-term memory for words is affected by context variability. In addition, future work should address whether variability of more complex backgrounds affects novel label retention more than less complex backgrounds. It is possible that complex, salient backgrounds only affect immediate attention, meaning children would demonstrate robust retention for word-object pairings.

As children become more adept at disambiguating a word's referent, however, the kinds of contexts used in Experiment 1 may affect their word learning success less. In line with this possibility, Vlach and Sandhofer (2011) found that 3- and 4-year-olds show robust word learning when presented with novel objects in contexts similar to those used in Experiment 1. Indeed, there is substantial evidence that humans are adept at using co-occurrence statistics to link words with their referents across different exposures. For example, adults attend to how frequently an object and label occur together (e.g., Trueswell et al., 2013; Vlach & Sandhofer, 2014; Yu & Smith, 2007; Zettersten, Wojcik, Benitez, & Saffran, 2018). Work with infants (e.g., L. Smith & Yu, 2008), toddlers (e.g., Scott & Fisher, 2012), and school-aged children (e.g., Suanda, Mugwanya, & Namy, 2014) has found similar patterns of effects across development. In the case of backgrounds that contain nameable items, children may eventually rely on the high co-occurrence of a target object and a novel label to successfully pair the two. It is important to note, though, that children may only start to retain co-occurrence statistics toward the end of early childhood (Vlach & DeBrock, 2019). It seems, then, that cross-situational word learning could be one way children overcome competitor variability to learn words, but this skill may be less robust in younger children. A lack of cross-situational statistical tracking could partially explain condition differences in Experiment 1.

Children may overcome context effects during word learning another way: an evolving understanding of how words function. Although words are communicative tools that function independently of context, children do not gain this insight until around age 2. Before attaining this understanding, younger children may build less robust representations of words that are more reliant on simple associations between sound forms and referents (Nazzi & Bertoncini, 2003). This could be why young children demonstrate context-dependent word learning in some cases (e.g., Goldenberg & Johnson, 2015; Vlach & Sandhofer, 2011). Before children grasp the communicative, symbolic nature of words, they may incorrectly associate a new label with a wide range of contextual factors during exposure. As they begin to show a more mature understanding of words, this tendency may decrease.

Even if children have gained some insight about how words work as symbols, there may still be cases when context affects word learning. Indeed, there is some evidence that even adults demonstrate context-dependent word learning (e.g., Finch et al., 2016). Perhaps certain contexts – those that are complex, salient, or distracting in some way – invite children to focus on them, incorrectly pairing a label with irrelevant features. These contexts may affect word learning more often in younger children who are less certain about what exposure features are relevant when encountering a new word. For this reason, 2-year-olds may sometimes demonstrate context-dependent word learning (e.g., Vlach & Sandhofer, 2011) and other times may not (e.g., Tippenhauer & Saylor, 2019). As children age, their representations of words may become more robust through their experiences with word learning more generally. One way to test this empirically would be to explore whether the strength of a representation, as indexed by exposure to a novel word or object (e.g., Kucker & Samuelson, 2012), protects children against context-dependent word learning. If additional experience prevents context-dependent word learning, it would suggest that more robust representations may not include information about context. Of course, this hypothetical experiment would only address limited, laboratory experience. It is likely that children's real-world experience with words is much more nuanced and structured, helping them understand that context should not affect the symbolic meaning of words (e.g., Nazzi & Bertoncini, 2003). The emergence of children's context-independent word learning may shed new light on the developmental progression in children's understanding of words as decontextualized symbols.

Understanding how children overcome context variability during word learning could provide important insight into processes underlying learning and memory and more generally. Indeed, recent research has found a link between decontextualized vocabulary at age 2 and later cognitive skills (Friend, Smolak, Liu, Poulin-Dubois, & Zesiger, 2018; Friend, Smolak, Patrucco-Nanchen, Poulin-Dubois, & Zesiger, 2019). In particular, children who are able to identify and use words in the absence of supportive learning contexts are better at learning print letters and numbers than children who are less able to identify words outside of exposure contexts (Friend et al., 2018; 2019). It seems, then, that early emergence of context-independent word learning is predictive of later competencies. However, it is not clear why this relation emerges. It could be the case that children who are good at learning words independently of context factors are better at pulling out relevant information from a complex or salient environment. This could make identifying meaningful units, like letters or numbers, easier when presented with complex strings of text. Future research should work to directly characterize this link.

The ability to decouple word-object pairings from exposure contexts could contribute to language acquisition difficulties in both typical and atypical populations. Context-dependent word learning could, for example, partially explain why children underextend words (e.g., Kamhi, 1982; Kay & Anglin, 1982; Wałaszewska, 2011). Moreover, individuals with Autism Spectrum Disorder (ASD) demonstrate some difficulty in generalization of words across category members. Although individuals with ASD are able to generate categories, they are often slower (e.g., Gastgeb, Strauss, & Minshew, 2006) and less consistent (Naigles, Kelley, Troyb, & Fein, 2013) in how they extend new words compared to people without ASD. It could be the case that individuals with ASD have a harder time identifying the relevant pieces of information during a labeling episode, leading to challenges with later generalization. This difficulty could be compounded by the chaotic environments in which word learning often takes place. Interestingly, the ability to generate categories may be related to language skills in people with ASD (e.g., Hani, Gonzalez- Barrero, & Nadig, 2013; Harley & Allen, 2014). More specifically, people with better language skills are more adept at using relevant cues to build categories (Hani et al., 2013). This could be additional support for the idea that some metalinguistic insight into the symbolic, referential nature of words drives the ability to generalize across contexts. This is a fascinating avenue for future research.

It is important to acknowledge that research exploring context-dependent word learning – including this dissertation – has taken a different approach than research exploring context effects on other kinds of learning. In much of the work on context-dependent memory, the primary question is whether similarity between learning and test environments promote retrieval (e.g., S. Smith, 2013; S. Smith & Vela, 2001). For example, researchers have explored whether adults recall more words from a list if tested in the same environment in which they studied (e.g., Godden & Baddeley, 1975). In word learning research, on the other hand, the focus has been primarily been whether context variability disrupts word learning. This dissertation suggests that certain contexts are more likely to disrupt word learning than others. More specifically, contexts containing nameable entities may disrupt 2-year-olds' word learning but less complex contexts may not. This finding may be at odds with memory research that has found facilitative effects of training in multiple environments compared to training in just one environment (e.g., Rovee-Collier, 1991; S. Smith et al., 1978). The difference between the literatures could emerge because of differences in how to succeed at learning words and other pieces of information. Acquiring a label requires generalization over exemplars (e.g., Behrend et al., 2001) and speakers (e.g., Goldenberg & Sandhofer, 2013b) as well as wider environments (e.g., Sandhofer & Schonberg, 2020). This may not be true of learning the types of information common in context-dependent memory research (e.g., Amabile & Rovee-Collier, 1991; Godden & Baddeley, 1975; Rovee-Collier & Dufault, 1991; S. Smith & Vela, 2001). Nevertheless, future work should directly explore why context variability may disrupt word learning and facilitate learning other pieces of information.

CHAPTER 5

Conclusion

Determining the role of context in word learning is crucial to understanding lexical development (see Horst & Simmering, 2015 for additional discussion). Children experience words in learning contexts replete with irrelevant contextual features (e.g., Medina et al., 2011; Samuelson & McMurray, 2017; Trueswell et al., 2016). Recent work has attempted to explore whether this perceptual chaos affects word learning in controlled research settings (e.g., Twomey et al., 2017; Vlach & Sandhofer, 2011; Werchan & Gómez, 2014). It is important to note, however, that context effects extend beyond the constrained, arbitrary backgrounds often used in laboratory settings. There is evidence that infants show context-dependent word learning in naturally occurring contexts (e.g., Perry, Samuelson, & Burdinie, 2014). Differences in real-world contexts, such as changes in physical space, are likely more salient than differences between cloth or computer backgrounds. However, the salient contexts used in this dissertation may reflect the perceptual clutter of children's naturalistic learning environments. Regardless, the present work raises the critical point that some types of context variability may be more difficult to overcome than others. Therefore, proposed mechanisms of word learning must account for successful label acquisition in variable, complex exposure environments.

Let us return now to the young child mentioned in the first paragraph of this dissertation. The messy environment in which she is hearing the word *asparagus* and sees the referent, actual asparagus, could affect her ability to link the two. Predicting whether or not her memory for the meaning of *asparagus* is context-dependent, however, is itself somewhat context-dependent. More specifically, whether the label is incorrectly linked with some feature of the exposure (e.g., dinnertime) depends on the environment as well as the learner herself. In terms of the environment, it seems that context will most likely affect word learning if the context is salient, complex, or distracting. For the child, her understanding of language and words is crucial. More specifically, she must understand that words function across contexts as well as which features of an exposure are relevant to learning a label's meaning. The child must suppress the irrelevant features in order to decontextualize the label-referent pairing. Even if the child does initially bind the word *asparagus* with some features of this particular exposure, she will eventually overcome that tendency. With additional language experience, this young child will learn that labels are symbols, eventually recognizing the ways in which words are used across contexts, speakers, and exemplars.

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