

PERSPECTIVE

The map trap: Why and how word learning research should move beyond mapping

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Abstract

A pervasive goal in the study of how children learn word meanings is to explain how young children solve the mapping problem. The mapping problem asks how language learners connect a label to its referent. Mapping is one part of word learning, however, it does not reflect other critical components of word meaning construction, such as the encoding of lexico-semantic relations and socio-pragmatic context. In this paper, we argue that word learning researchers' overemphasis of mapping has constrained our experimental paradigms and hypotheses, leading to misconceived theories and policy interventions. We first explain how the mapping focus limits our ability to study the richness and complexity of what infants and children learn about, and do with, word meanings. Then, we describe how our focus on mapping has constrained theory development. Specifically, we show how it has led to (a) the misguided emphasis on referent selection and ostensive labeling, and (b) the undervaluing of diverse pathways to word knowledge, both within and across cultures. We also review the consequences of the mapping focus outside of the lab, including myopic language learning interventions. Last, we outline an alternative, more inclusive approach to experimental study and theory construction in word learning research.

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child-directed speech, label-referent mapping, lexico-semantic network, ostensive labeling, word learning

1 | INTRODUCTION

As adults, when we encounter a new word, we often try to map it to its referent, either by deducing the meaning from context or by looking it up in a dictionary. A child learning their first language(s), we may intuitively reason, is also singularly focused on linking labels to referents. Indeed, many academic articles about early word learning open by citing the inscrutability of reference, or “Gavagai” problem (Quine, 1960), to motivate the investigation of how children

connect a word to its referent despite ambiguity in the input.¹ This common motivating question—how infants determine the referent of a word—is called the mapping problem.

Mapping has historically been a common focus in psychological research on word learning. Despite foundational descriptive work that explored multiple facets of word learning (e.g., Bates et al., 1975; Bowerman, 1973; Brown, 1973), a pervasive approach in the early study of how children learn word meanings was to propose and test mechanisms that explain how children solve the mapping problem, while learning to ignore mapping-irrelevant information (Bloom, 2000; Carey & Bartlett, 1978; Golinkoff et al., 2000; Markman & Wachtel, 1988). For example, sociopragmatic cues, like pointing, can help children focus in on the referent to be mapped, rather than other parts of the scene (Baldwin, 1993; Clark, 1990; Tomasello & Akhtar, 1995); syntactic information can allow a learner to hone in on a single referent in a scene to the exclusion of other referents (Gleitman, 1990; Naigles, 1990); and biases to link one word with one referent lead learners to search for a novel object whose name is unknown while ignoring objects whose names are known (Golinkoff et al., 1994; Hollich et al., 2000; Markman, 1990). What these proposals share is the assumption that learning a word's meaning is fundamentally about finding a label's referent while ignoring irrelevant information, leading to a wealth of research that equates word learning with word mapping.

While many contemporary theoretical proposals have shifted focus away from or even explicitly criticized framing word learning as mapping (Elman, 2009; Lupyan & Lewis, 2019; McMurray et al., 2012), these proposals have often inherited aspects of the word-mapping-as-word-learning framework. For example, studies on word learning often contextualize questions as addressing the inscrutability of reference problem (e.g., by opening the paper with a reference to Quine's "Gavagai" problem; Horst et al., 2011; Xu & Tenenbaum, 2007; Smith & Yu, 2008); teach novel words using ostensive training paradigms in which learners are guided towards the goal of mapping a label to a concrete referent (e.g., Borovsky et al., 2016; Roseberry et al., 2014; Wojcik & Saffran, 2013); and test word knowledge using referent selection tasks that only require learners to identify mappings between a label and a referent (e.g., Bergelson & Swingley, 2012; Medina et al., 2011; Ramscar et al., 2013). Indeed, in some of our own work in which we have attempted to move beyond mapping (Zettersten et al., 2018), we frame one of the main word learning problems as referential ambiguity while citing Quine, and we train and test learners in a task in which the explicit goal is to map labels to referents.

In this paper, we show that the continued focus—both explicit and implicit—on the mapping problem has constrained our experimental paradigms and hypotheses, leading to theories and policy interventions that do not reflect the full word learning process. We first explain how the mapping problem has limited the study of word learning. Then, we describe the downsides of the mapping focus both in the lab and in the real world. Last, we outline an alternative, more inclusive approach to experimental study and theory construction in word learning research.

2 | THE LIMITS OF THE MAPPING FOCUS

Mapping labels to referents is one component of learning word meanings. However, the framing of word learning as *primarily* a mapping problem narrows the lens of word learning research. First, the mapping focus often requires researchers to create novel words that have single, stable imageable meanings, despite the fact that linguists and psychologists have long acknowledged that there is no necessary and sufficient meaning for a given word (Elman, 2009; Medin & Smith, 1984; Ramscar & Port, 2015; Rosch & Mervis, 1975; Wittgenstein, 2009). Even concrete nouns that are commonly used in input to children have polysemous, context-sensitive meanings. For example, when *chicken* is used at dinner, it refers to food. On a farm, chickens refer to animals with feathers that cluck. Other referents, such as stuffed animals, may have none of these properties (Floyd & Goldberg, 2021; Rabagliati & Snedeker, 2013). However, studying word learning as word mapping requires researchers to choose a core referent to present to children. This practice implicitly diverts researchers away from the study of richly context-dependent and flexible meanings, despite the fact that many researchers acknowledge that this flexibility is crucial to mature word use.²

A second, related limitation of the mapping focus is that it necessitates that lexico-semantic associates and contexts are set aside while we first investigate "pure" word knowledge. It is tempting to see non-mapping information as window dressing for the central problem of mapping labels to referents. For example, Bloom's influential book on word learning (2000) calls nonmapping information "broad" knowledge and does not cover it at all. However, experimental work with adults and children demonstrates that word comprehension and production are always affected by non-mapping knowledge (see Elman, 2009). Linguistic knowledge guides the syntactic frames that words are put in (Arnon & Clark, 2011), pragmatic knowledge affects the interpretation of the same word in different contexts

(Gibson & Pearlmuter, 1998), and semantic and phonological associates affect how easily new words are learned (Hills et al., 2010). Learners not only encode word-referent associations, but also simultaneously encode information about the relationship between different referents, such as which items tend to appear together (Zettersten et al., 2018) or look similar (Wojcik & Saffran, 2013), as well as information about underlying category structure (Borovsky et al., 2016; Chen et al., 2018) and syntax structure (Rebuschat et al., 2021). Despite the fact that nonmapping information is not peripheral, the mapping focus makes the first goal of word learning research to solve the mapping problem, and thus nonmapping information is often automatically relegated to the back burner, both in terms of experimental programs and theoretical modeling.

Finally, the mapping focus limits theories by implying that an infant's primary goal is to match labels to referents. Particularly in the first years of life, young children's engagement with the world is exploratory (Kidd & Hayden, 2015; Oudeyer & Smith, 2016), and thus it is unlikely that they approach each utterance of a word as an opportunity to find its referent. Adults in some cultures and contexts may be focused on helping infants map labels to referents, but at any given moment, infants themselves are attempting to solve acute, local problems such as how to move an object, elicit a response from a caregiver, or find a toy. Moreover, grasping a toy when a label is heard may be the solution to a temporary communication problem rather than the encoding of a mapped representation (Horst & Samuelson, 2008). In some contexts infants will have mapping as a goal (Chouinard et al., 2007), but they are likely to have situation-specific, local goals that frequently override attention to the mapping problem. By focusing word learning on word mapping, researchers are held back from creatively investigating other hypotheses about infant attention during language development.

Label-referent mapping is indeed one component of building word meanings. However, the strong focus on word mapping has artificially constrained word learning research. Specifically, word mapping approaches often cause experiments and theories to implicitly devalue the fact that word meanings are context-dependent, that learners encode non-mapping information about words, and that infants' primary goal is not always mapping. The consequences of these limitations can be seen in both theoretical and applied research on word learning.

3 | CONSEQUENCES OF THE MAPPING FOCUS

The mapping focus has affected the study of word learning at multiple levels. We first describe two consequences of the mapping focus on basic research. Then, building on those basic research consequences, we describe how the mapping focus has led to myopic language interventions.

3.1 | A misguided deification of referent selection and ostensive labeling

Because word learning is equated with mapping, most word learning studies use a mapping test—namely visual referent selection—as the outcome measure. Visual referent selection refers to any task that involves looking to, pointing at, or otherwise indicating the referent that best matches a label. There are many advantages to visual referent selection tasks: they are easy to implement, can be analyzed at multiple behavioral levels, and offer clearly interpretable insight into children's activation of word meanings. However, children know much more than what can be revealed by the selection of an object alone (e.g., Brown & Berko, 1960; Wojcik, 2018). Additionally, the predominant use of referent selection tasks affects not only what we can discover about early word meanings, but also our theories about how those meanings are learned.

Several decades into studying children's behavior on visual referent selection tasks, we are skilled at training children to succeed at locating target referents. Specifically, we have discovered that an efficient path to successful referent selection is to directly reinforce the object-label association via ostensive labeling. Ostensive labeling is a direct statement of a label while an infants' attention is directed towards the relevant referent. The fact that ostensive labeling is a particularly effective way to train children on visual referent selection tasks is valuable to our understanding of the mapping problem (despite its tautological nature). However, because of the field's mapping focus, successful word learning has become equated with success on visual referent selection, and we have inflated the importance of ostensive labeling such that it is often described as the gold-standard moment for word learning writ large (Axelsson et al., 2012; Huttenlocher et al., 1991; Tan & Schafer, 2005). Word learning research has fallen prey to Goodhart's Law: "When a measure becomes a target, it ceases to be a good measure" (Strathern, 1997).

The field's deification of ostensive labeling would be less suspect if ostensive labeling moments were universally common in the language children hear. However, examinations of the language of children's natural environments show that ostensive labeling can be rare. Day-to-day language contains high intra-individual variability, is embedded within routine activities, and is not always referent-centered, instead being often organized around actions and interactions (Casillas et al., 2020; Tamis-LeMonda et al., 2017). Further, language beyond ostensive labeling events contributes to learning words. Routine-centered language can highlight the communicative consequence of a word rather than its abstract referent (Tamis-LeMonda et al., 2017). The meaning of the word “uh oh”—one of the words children learn earliest in English—is perhaps that it elicits help, rather than a definable referent (Casey et al., 2021). By focusing on ostensive labeling and how it promotes referent selection, we miss the real-world dynamics of language input and how it contributes to children's word learning.

3.2 | The undervaluing of cultural differences in early language environments

The complex dynamics of children's language environments suggest not only that referent selection and ostensive labeling are overvalued, but also that there may be multiple pathways to learning word meanings. The mapping focus, however, has led us to disproportionately value a specific pathway to word learning: a high number of ostensive labeling moments that optimize children's accuracy in referent selection tasks. In turn, we undervalue other pathways in lexical development. This is not a new critique; others have argued that the language abilities of the privileged majority are often viewed as the standard, and language abilities of children from low-income or minoritized backgrounds are often seen as “deficient” (Dudley-Marling & Lucas, 2009; Figureoa, 2022; Flores & Rosa, 2015; Miller & Sperry, 2012). Here, we highlight two examples of how *the mapping focus* contributes to the undervaluing of diverse pathways to word knowledge: (1) underestimation of multilingual children's word knowledge and (2) overvaluing of child-directed activities.

First, the mapping focus has contributed to the idea that multilingual children are “behind” their monolingual counterparts. This view stems from work measuring word knowledge using referent selection tasks, in which multilingual children score lower than monolingual children (Hoff & Ribot, 2017). Yet, multilingual children show equal or enhanced skills when considering other kinds of word knowledge, such as the links between words within and across languages (De Anda & Friend, 2020; Jardak & Byers-Heinlein, 2019) and sensitivity to the pragmatic context of words (Groba et al., 2018). By relying on referent selection as our primary window into word meanings, we underestimate multilingual children's language skills, leading to a deficit perspective when assessing multilingual word learning trajectories (López et al., 2021).

Second, the mapping focus has led to the overvaluing of two child-directed activities: book reading and child-directed speech. Both book reading (Farrant & Zubrick, 2012; Mol et al., 2008; Richman & Colombo, 2007) and child-directed speech (Rowe, 2012; Weisleder & Fernald, 2013) are positively linked with word knowledge as measured via referent selection. Researchers often consider these child-directed activities to be high-quality word-learning activities because they are likely to present a high number of ostensive labeling events (e.g., Cartmill et al., 2013; Farrant & Zubrick, 2012). The resulting assumption is that the absence of these experiences equals an absence of rich experiences that build word knowledge.

However, these specific experiences are not necessary for word learning. Child-directed speech (rife with ostensive labeling) is infrequent in some nonwestern contexts, and yet children's word learning trajectories are similar to children in western contexts (Casillas et al., 2020; Shneidman & Goldin-Meadow, 2012). While some interpret this finding as demonstrating the power of ostensive labeling moments—children can learn words from only a few utterances!—it is equally likely that children are learning word meanings from, not despite, other types of input. Non-referent-centered speech occurs in the context of activities with social partners, highlighting how words are connected with agents, objects, actions, and how a child should respond in a specific linguistic context (Casillas et al., 2020). Indeed, there is evidence these types of non-referent-centered language experiences contribute significantly to word knowledge. For example, storytelling outside of book reading supports children's comprehension and use of words within a narrative context (Isbell et al., 2004; Lenhart et al., 2020; Leyva & Smith, 2016; Reese et al., 2010). By overvaluing activities that boost encounters with and knowledge of word-referent maps, we miss the opportunity to examine how other activities in the daily lives of young children contribute to building word knowledge across diverse contexts.

3.3 | Myopic interventions

Our undervaluing of nonmapping aspects of word learning also has consequences for interventions, policies, and the public perception of how to best support language development. The effectiveness of a certain type of child-directed speech, focused on ostensive labeling, has led to a proliferation of interventions and policies that train parents to engage in activities that promote mapping, such as a point-and-label style of talk and reading (e.g., Wong et al., 2020). These interventions are popular for many reasons: they are relatively easy to implement (compared to fixing structural inequities such as income gaps) and target an easy-to-measure outcome (vocabulary size) that is linked to academic success (Duff et al., 2015). However, we worry that focusing on increasing the type of input that supports mapping is myopic. An embrace of the rich learning moments that contribute to all aspects of word knowledge will lead to interventions that both more effectively support the full word learning process and also better value and integrate intra- and intercultural variability in child-rearing practices.

4 | ALTERNATIVE APPROACHES TO THE STUDY OF WORD LEARNING

To this point, we have voiced our concerns with the mapping focus in word learning research. Studying how children map labels to referents continues to be important (all authors on this paper have contributed to this literature). Our appeal is for a conscious decentering of mapping and a move toward embracing diverse learning opportunities and types of word knowledge. We believe that the most pressing issues involve examining the richness of lexical-semantic knowledge, investigating how diverse experiences support word knowledge beyond word mapping, probing individual differences in early word knowledge, and understanding how babies experience the world. Each of these lines of work move away from framing word learning as label-referent mapping and from focusing primarily on ostensive labeling and referent selection in experimental or modeling tasks.

4.1 | Modeling and testing rich lexical-semantic knowledge

When a child hears a word in the real world, it is surrounded by contextual information that ranges from the acoustics of the speech stream all the way up to the social circumstances. What aspects of a context do learners absorb when hearing new words? Several lines of work have begun to illustrate the rich knowledge learners build while learning new words by querying not just learners' retrieval of simple object-label associations, but also their knowledge of other relations that are important for developing lexical-semantic knowledge. Computational modeling has been used to explore what types of semantic structure emerge in models trained to predict word sequences in corpora of child-directed speech (Fourtassi, 2020; Huebner & Willits, 2018), large general corpora of language (Lewis et al., 2019; Thompson et al., 2020), and combinations of language and image corpora (e.g., Roads & Love, 2020). What is notable about these modeling results is that rich lexical-semantic knowledge (such as hierarchically structured categories like MAMMAL and FAMILY; knowledge about visual structure, like the relative size of different animals) emerges in the absence of ostensive training on word-referent mappings or explicit training on word meanings more broadly (but see also Lake & Murphy, 2021 for discussion of some current limitations of such models).

Other recent research demonstrates what lexical-semantic information children learn when we probe their knowledge outside of ostensive training paradigms and beyond referent selection tasks. When infants encounter new words, they do not only encode word referents, but also use words to construct novel categories (Chen et al., 2018; Ferguson & Waxman, 2017; LaTourrette & Waxman, 2019); encode knowledge about semantic, perceptual, and collocational similarity (Fourtassi et al., 2020; Peters & Borovsky, 2019; Unger & Fisher, 2021; Wojcik & Saffran, 2015); track polysemous meanings (Floyd & Goldberg, 2021; Srinivasan et al., 2019); store syntax structure (Rebuschat et al., 2021); and incorporate speaker characteristics (Brooker & Poulin-Dubois, 2013). Future work should continue to use computational modeling and innovative behavioral testing paradigms to probe diverse aspects of lexical-semantic knowledge that learners may encode from their broader learning environment.

4.2 | Describing word learning in diverse contexts

A fundamental insight in language research is that there are many potential routes to language development (Kidd et al., 2020). Infants navigate worlds that vary in social, pragmatic, and cultural constraints, and yet typically developing

children across all cultures successfully learn the words of their language(s), allowing them to communicate within their community. What do children encode about words when there is less ostensive labeling? How do the verbal and social environments of different social and cultural groups support rich word knowledge? The full answer to these questions is unknown, in part because a disproportionate amount of experimental work is focused on the mapping problem. Some researchers are beginning to embrace the diversity of paths to word learning. Oral storytelling has been found to be associated not only with word mapping, but also other skills such as narrative comprehension and prolonged linguistic engagement (Lenhart et al., 2020). Cross-cultural work is beginning to unpack how word learning unfolds in cultures with less ostensive labeling (Casillas et al., 2020; Cristia et al., 2019). Cultural values are often embedded into the language interactions of caregivers with their child, with potential consequences for early word knowledge (Adamson et al., 2021; Tamis-LeMonda et al., 2020; Winstone et al., 2021). Embracing the diversity of paths in both experimental and observational work will continue to help us understand word learning, particularly if researchers are careful to also study nonmapping aspects of learning.

4.3 | Centering individual differences in word learning

In addition to embracing inter-cultural differences in word learning, researchers should also study and model individual differences. Such individual differences have often remained masked in past word learning research due to the focus on how learners map labels to a standardized, constrained set of referents. Recent research shows that word meanings—and their associated learning trajectories—show richer variation than previously thought. Using both behavioral and neuroimaging methods, Wang and Bi (2021) found that adult meaning representations are highly idiosyncratic (see also Martí et al., 2021). Relatedly, recent modeling work demonstrates that children's individual semantic networks and environments affect vocabulary growth (e.g., Beckage et al., 2020; see also Samuelson, 2021 and Frank et al., 2021). For example, bilingual children's early learned words in one language facilitate the learning of translation equivalents (Bilson et al., 2015). By modeling and testing the idiosyncratic paths that individuals take to learning word meanings (not just word mappings), we can better understand the richness of word knowledge.

4.4 | Thinking from a baby's perspective

Last, we encourage researchers to “think from a baby's perspective.” Because we were all once children, and because many researchers interact with children every day, it is easy to assume that we know how babies see, hear, and interact with the world. However, as adults, our experience has shaped what we attend to and how we chunk complex sensory input (e.g., Harel & Bentin, 2013). Thus, our intuitions about what babies experience and encode in the absence of these biases may not be correct. For example, a recent study found that both parents and researchers believe they can identify the visual referent that a baby will associate with a word like “uh oh” or “bye”; however, these adult intuitions seem to be incorrect (Casey et al., 2021).

One methodological approach to thinking from a baby's perspective is to conduct descriptive work using naturalistic datasets. There has been an increase in the collection of naturalistic datasets (e.g. Bulgarelli & Bergelson, 2020; Mendoza & Fausey, 2021; Sullivan et al., 2021) that differ from past corpora in that they (a) include video data, sometimes from head cameras capturing first-person sensory input, (b) are densely sampled across days and times of day, and/or (c) follow children longitudinally. We encourage researchers to not only code traditional cues and features, such as caregiver points or object presence (e.g., Custode & Tamis-LeMonda, 2020), but to also use these datasets to ask new questions about how babies may use the rich information in their environment—perhaps information to which we ourselves do not implicitly attend—to construct word representations (e.g., Kosie et al., 2021).

5 | CONCLUSION

Mapping a label to a referent is one component of word learning, but it is not all there is to learning words. In this paper, we described how a narrow focus on the mapping problem has limited theory development and word learning interventions. There is often an inertia in the scientific process that makes it difficult to see the broader themes that are being created with the research questions that we ask and how we ask them. As the study of word learning moves beyond its adolescence, we urge researchers to ask questions that decentralize the mapping problem. What are the

assumptions of the theory you are investigating, and do you agree with them? Are you using a certain paradigm because it best answers your question, or because it is convenient and canonical? What about your own background and experiences might bias your experimental design, analyses, and interpretation? By consciously examining our approach to the study of word learning, we can more fully embrace the complexity and richness of early language development.

ENDNOTES

- ¹ Ironically, Quine used the “Gavagai” problem to point out how perfectly shared reference is impossible, and thus not necessary for communication.
- ² Even if one believes semantic and pragmatic knowledge can (and should) be cleanly separated, this limitation applies. We can make more progress in understanding the boundaries of semantic knowledge by varying the pragmatics of our experimental paradigms.

AUTHOR CONTRIBUTIONS

Erica Wojcik: Conceptualization (equal); project administration (lead); writing – original draft (equal); writing – review and editing (equal). **Martin Zettersten:** Conceptualization (equal); writing – original draft (equal); writing – review and editing (equal). **Viridiana L. Benitez:** Conceptualization (equal); writing – original draft (equal); writing – review and editing (equal).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

RELATED WIREs ARTICLES

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