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Exploring socioeconomic differences in syntactic development through the lens of real-time processing

Yi Ting Huang [a,*], Kathryn Leech [b,c], Meredith L. Rowe [c]

[a] University of Maryland College Park, Department of Hearing and Speech Sciences, United States
[b] University of Maryland College Park, Department of Human Development and Quantitative Methodology, United States
[c] Harvard University, Graduate School of Education, United States

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ABSTRACT

Differences in caregiver input across socioeconomic status (SES) predict syntactic development, but the mechanisms are not well understood. Input effects may reflect the exposure needed to acquire syntactic representations during learning (e.g., does the child have the relevant structures for passive sentences?) or access this knowledge during communication (e.g., can she use the past participle to infer the meaning of passives?). Using an eye-tracking and act-out paradigm, the current study distinguishes these mechanisms by comparing the interpretation of actives and passives in 3- to 7-year-olds (n = 129) from varying SES backgrounds. During the presentation of spoken sentences, fixations revealed robust disambiguation of constructions by children from higher-SES backgrounds, but less sensitivity by lower-SES counterparts. After sentence presentation, decreased sensitivity generated interpretive challenges and average SES-related differences for passives requiring syntactic revision ("*The seal is quickly eaten by it*"). Critically, no differences were found when revision was not needed ("*It is quickly eaten by the seal*"). These results suggest that all children shared an ability to acquire passives, but SES-related differences in real-time processing can impact the accuracy of utterance interpretation.

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1. Introduction

Striking differences in vocabulary development have been found in language acquisition across socioeconomic status (SES) (Arriaga, Fenson, Cronan, & Pethick, 1998; Hart & Risley, 1995; Hoff, 2003; Weisleder & Fernald, 2013). Notably, these effects are also present in syntactic development (Dollaghan et al., 1999; Hoff-Ginsberg, 1986; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Morisset, Barnard, Greenberg, & Booth, 1990; Vasilyeva, Waterfall, & Huttenlocher, 2008), an area that is traditionally argued to be resilient to variation in learning environments (Borer & Wexler, 1992; Newport, Gleitman, & Gleitman, 1977). Relative to lower-SES counterparts, children from higher-SES backgrounds, on average, produce more complex utterances (e.g., number of clauses, words per sentence) and diverse constructions (e.g., number of structural relationships) (Huttenlocher et al., 2010; Vasilyeva et al., 2008). These distinctions are mirrored in the communicative input to children from varying SES backgrounds (Cartmill et al., 2013; Hart & Risley, 1995; Hoff, 2003; Huttenlocher et al., 2007; Rowe, 2012). Compared to lower-SES counterparts, caregivers from higher-SES backgrounds, on average, produce more complex syntactic structures such as *wh*-questions, relative clauses, and raising adjectives (Huttenlocher et al., 2010).

Yet, far less is known about *why* relationships between language outcomes and caregiver input emerge in the first place or *what* aspects of development they reflect. One possibility is that SES-related differences reflect variation in learning. If specific language experiences (i.e., input quantity or quality) are required to acquire syntactic representations, then children may simply fail to learn constructions that are not frequently encountered. A second possibility is that SES-related effects are far more targeted. While children may acquire syntactic knowledge with minimal experience, input properties may facilitate access to this knowledge during real-time comprehension. If so, then SES-related differences may be isolated to situations where efficient access to previously acquired representations is necessary for interpreting an utterance. However, when utterance interpretation does not depend on efficient access to representations, then SES-related differences in comprehension may be minimal. To distinguish between effects of language experience during learning (e.g., does

* Corresponding author at: Department of Hearing and Speech Sciences, University of Maryland College Park, College Park, MD 20742, United States.
E-mail address: ythuang1@umd.edu (Y.T. Huang).

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the child have syntactic representations?) versus communication (e.g., can she access them when she hears utterances?), the current study focuses on the comprehension of a low-frequency construction: the English *be*-passive. In the remainder of the Introduction, we will flesh out two perspectives on the role of caregiver input during syntactic development and examine their predictions for the scope of SES-related differences. We will then briefly consider why findings from prior research fail to distinguish between these hypotheses and discuss how the current study will tackle these limitations.

1.1. Two perspectives on input effects during language development

Accounts of SES-related effects on syntactic development often focus on how language experience impacts the acquisition of linguistic representations at the point of learning. As such, there is an underlying assumption that variable outcomes reflect differences in *forming* syntactic structures via frequency-driven associations between caregiver input and utterance meaning (Huttenlocher et al., 2002, 2007, 2010). These accounts share similarities to influential theories of acquisition including social-interactionist (Bruner, 1983; Snow, 1989) and usage-based approaches (Ambridge, Kidd, Rowland, & Theakston, 2015; Tomasello, 2000). They also provide an intuitive explanation for why SES-related effects are present in syntactic development. Since learning is predicated on adequate language experience, it is unsurprising that children from lower-SES backgrounds (who encounter less quantity and quality of input) lag behind their higher-SES counterparts (who encounter more), on average.

However, it is possible that the impacts of language experience may occur not at the point of *acquiring* representations, but when *accessing* this knowledge during communication. Recent research by Fernald and colleagues points to such a link in vocabulary development (Fernald, Marchman, & Weisleder, 2013; Hurtado, Marchman, & Fernald, 2008; Weisleder & Fernald, 2013). On average, 18-month-olds from lower SES families are slower to recognize highly familiar words in spoken sentences compared to their peers from higher SES families (Fernald et al., 2013). Individual variation in the speed of lexical processing predicts vocabulary size six months later, suggesting that real-time comprehension mediates relationships between language experience and vocabulary development. Nevertheless, the studies to date have focused on word recognition in simple and frequent syntactic contexts (e.g., "*Where's the dog?*"). Thus, it remains unknown how these effects influence development at later ages and in other language areas.

Interestingly, the role of input statistics is front and center in a parallel literature on adult syntactic processing. While theories differ in their goals and commitments, they share a basic assumption that the frequency of a structure directly affects its ease of retrieval from memory, e.g., limited repair parsing (Fodor & Inoue, 1994; Lewis, 1998), constraint-based models (MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell & Tanenhaus, 1994), surprisal theory (Levy, 2008), noisy-channel models (Gibson, Bergen, & Piantadosi, 2013; Levy, Bicknell, Slattery, & Rayner, 2009). The statistical properties of linguistic cues shed light on why sentences like (1a) are more difficult to comprehend compared to (1b), despite their equivalent meaning (Levy et al., 2009; Tabor, Galantucci, & Richardson, 2004). Since verbs like "*tossed*" are ambiguous between a relative-clause (i.e., the player who was tossed the frisbee → s/he received it) and active-clause interpretation (i.e., the player tossed the frisbee → s/he threw it), both syntactic structures are retrieved from memory when this cue is encountered in an utterance. In contrast, verbs like "*thrown*" are only consistent with a relative-clause interpretation, thus the likelihood that this structure is correctly accessed during comprehension is greater.

(1) a. The coach smiled at the player tossed the frisbee by the opposing team.
b. The coach smiled at the player thrown the frisbee by the opposing team.

Importantly, models of how input statistics shape comprehension within an individual may also explain how differences can arise between individuals. Even when syntactic knowledge is present across all children, variation in language experience may increase its ease of retrieval in some listeners compared to others. Efficient access may be particularly critical for interpreting garden-path sentences, where an initial syntactic analysis (e.g., hearing "*the player tossed the frisbee . . .*," thinking that s/he threw it) needs to be revised after encountering later linguistic cues (e.g., hearing "*. . . by the opposing team,*" realizing that s/he received it). To do so, children must use cues to retrieve an alternative structure that fits with the updated linguistic context. This turns out to be quite difficult during development. Unlike adults, school-aged children (typically recruited from higher-SES families) often resist revision and adhere to misinterpretations across a variety of constructions (Choi & Trueswell, 2010; Huang, Zheng, Meng, & Snedeker, 2013; Hurewitz, Brown-Schmidt, Thorpe, Gleitman, & Trueswell, 2000; Omaki, Davidson White, Goro, Lidz, & Phillips, 2014; Trueswell, Sekerina, Hill, & Logrip, 1999; Weighall, 2008). Yet, little is known about how language experience impacts revision abilities during development and how these effects may contribute to SES-related differences in syntactic abilities.

1.2. Why comprehension of the passive construction may be informative

One challenge to addressing these questions is the widespread reliance on aggregated measures of language performance (e.g., mean length utterance, number of clauses, standardized assessments). These tools provide excellent summaries of the range of SES-related effects, but they can also obscure their underlying causes. In particular, these approaches fail to distinguish between whether SES-related differences in language comprehension reflect variation in the acquisition of syntactic representations (i.e., properties of caregiver input enables *some* but not all children to learn syntactic structures) versus real-time retrieval during communication (i.e., *all* children have knowledge of structures, but caregiver input enables some to access this more efficiently). Thus, to isolate the mechanisms underlying SES-related differences during syntactic development, it is necessary to adopt finer-grained measures of performance.

To this end, the current study focuses on children's comprehension of a well-studied test case: the active-passive alternation. Both constructions express the basic relationship of who did what to whom. In active sentences like (2a), the first noun phrase (NP1) maps onto the agent ("*the seal*" = PREDATOR) while the second noun phrase (NP2) maps onto the theme ("*the fish*" = PREY). In passive sentences like (2b), this order is reversed: NP1 is now the theme ("*the seal*" = PREY) while NP2 is the agent ("*the shark*" = PREDATOR). It is well documented that children readily comprehend actives, but generate many errors with passives (Gordon & Chafetz, 1990; Harris & Flora, 1982; Huang et al., 2013; Maratsos, Fox, Becker, & Chalkley, 1985; Messenger, Branigan, & McLean, 2012; Stromswold, Eisenband, Norland, & Ratzan, 2002; Sudhalter & Braine, 1985). This asymmetry has inspired several theories of syntactic development (see Huang et al., 2013 for a review). For our present purposes, we focus on two prominent accounts and consider their predictions for SES-related differences.

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