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Inbal Arnon


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## Can Mimicking Infants' Early Experience Facilitate Adult Learning? A Critique of Hudson Kam (2017)

Inbal Arnon

Department of Psychology, Hebrew University, Jerusalem, Israel

### ABSTRACT

Why do adults seem to struggle more than children in learning a second language, despite being better at a range of other cognitive skills? The source of L1-L2 differences in language learning is one of the most debated topics in the study of language. One hypothesis is that L1-L2 differences are primarily experience-based, with language learning abilities themselves showing a high degree of plasticity. Hudson-Kam (2018) recently presented findings that seem to go against this hypothesis: in five studies, adults failed to show better learning in a more infant-like environment. In this article, I offer a theoretical and empirical critique of these findings and outline some open questions for investigating experience-based explanations for L1-L2 differences. In short, the main critique has to do with how we define what infant-like (or child-like) learning is and how we identify which aspects of children's experience facilitate which aspects of language learning.

Why do adults seem to struggle more than children in learning a second language, despite being better at a range of other cognitive skills? The source of L1-L2 differences in language learning is one of the most debated topics in the study of language. Understanding why and when children and adults differ in their learning trajectories has far-reaching theoretical and practical implications: it can illuminate both the basic mechanisms of language learning in infancy and the way such learning can be facilitated in adult learners. There are, of course, many differences between children learning a first language and adults learning a second: L1 and L2 learners differ in their cognitive and neurological make-up, in the amount and kind of linguistic input they receive, and in what they already know, both about language and about the world.

Many of these differences are unchangeable: we cannot undo the way a human brain has developed or reverse the increase in memory or attention that comes with age. If adults' difficulty stems solely from these maturational aspects of development, there is little that can be done to enhance their language learning. On the other hand, other aspects, such as the kind of input learners are exposed to, *can* be manipulated. If adult learning is hindered by the structure of their linguistic environment or the way they approach learning a novel language, then making adults learn in a more "child-like" or "infant-like" fashion should lead to better language learning outcomes. This prediction stems from the hypothesis that L1-L2 differences are experience-based, with language learning abilities themselves showing a high degree of plasticity. Hudson-Kam (2018) recently presented findings that seem to go against this hypothesis: in five studies, adults failed to show better learning of grammatical-gender patterns in a more infant-like environment. In this article, I offer a theoretical and empirical critique of these findings and outline some open questions for investigating experience-based explanations for L1-L2 differences. In short, the main critique has to do with how we define what infant-like (or child-like) learning is. While making adults learn like

children is intuitively appealing, the challenge lies in defining exactly what it means to mimic the child's experience, in terms of both learning environment and learning mechanisms.

The idea that there is something uniquely facilitative about how children learn language has a long history in the study of L1-L2 differences. In her influential Less-is-More hypothesis, Newport (1990) proposed that children's smaller memory capacities help them make linguistic generalizations by limiting their ability to store forms holistically. Children's advantage is related to their cognitive make-up: being child-like means having smaller memory resources. Elman (1993) focused on the properties of children's input, using neural network simulations to show that being exposed first to short transitive sentences and only then to more complex ones facilitates learning of long-distance dependencies. Focusing on another aspect of development, children's lower cognitive control is related to their better learning of linguistic conventions by preventing them from ignoring infrequent variants (Thompson-Schill, Ramscar, & Chrysikou, 2009). A more recent proposal relates children's advantage to the way prior knowledge interacts with the linguistic environment to impact the units of learning. The Starting Big Hypothesis (SBH; Arnon, 2010; Arnon & Christiansen, 2017) suggests that children make use of multiword units (crossing lexical word boundaries) in learning language (Arnon & Clark, 2011; Arnon, McCauley, & Christiansen, 2017); that adults do so less because of their existing knowledge of words (Arnon & Christiansen, 2017; McCauley & Christiansen, 2017); and that learning from multiword units is beneficial for certain semantically-opaque grammatical relations that hold between words (Arnon & Ramscar, 2012; Siegelman & Arnon, 2015). Being child-like, in this proposal, means that you are learning multiple aspects of language simultaneously: children are more likely to extract multiword units because they don't know what words are, and are learning word boundaries, meaning and structure at the same time.

The SBH predicts that manipulating adults' input—by making word units less salient and having adults learn word boundaries and meaning simultaneously—should lead (a) to the extraction of more multiword units and (b) to better learning of certain grammatical relations. This prediction has been supported in a series of artificial language learning studies looking at gender-like agreement patterns. The first showed better learning of article-noun pairings in adults when exposed first to full sentences and only then to nouns in isolation (compared to hearing first single words and then sentences; Arnon & Ramscar, 2012). In this condition, participants were learning meaning and segmentation simultaneously, simulating a more child-like environment (speech was always accompanied by visual scenes). The second study improved the manipulation and provided more direct evidence for the link between unit-size and learning outcomes (Siegelman & Arnon, 2015). Learning was better when participants heard unsegmented sentences (without pauses) before segmented ones (with pauses) compared to the other way around (both groups heard the same input, just in different order). Such exposure is more similar to infants' early experience. The improvement was related to unit size: treating the article-noun as one word led to better learning of the relation between them. A similar pattern was found when looking at English speakers' learning of Chinese classifiers: early exposure to larger units led to better learning outcomes (Paul & Gruter, 2016). Together, these studies show that making adults learn from larger units, as children are postulated to do, can facilitate learning of certain grammatical relations. That is, making adults learn in a more "child-like" fashion can lead to better outcomes.

A recent paper challenges this conclusion. Hudson-Kam (2018) investigated adults' learning of grammatical gender-like patterns. Learners were exposed to an artificial language with a gender-like system: nouns belonged to one of two classes, and this impacted agreement patterns. Each noun class was associated with a distinct noun class marker (suffixed to the noun) and verbal agreement marker (appearing at the end of the verb). The classes did not have a semantic basis, but there were phonological cues to class membership (back vowels vs. front vowels). The main manipulation involved changing learners' initial exposure to the language. Learning was compared in two conditions. In the experimental condition learners were first exposed to speech alone, (for 2–4 days) and only then to speech coupled with meaning (visual scenes describing actions and objects). In the control condition, learners were exposed to speech + meaning from the very start. The author

hypothesized that learning will be better in the experimental condition because it is more similar to infants' language environment and will encourage learners to use phonological bootstrapping to learn the grammatical categories. However, no learning advantage was found for the experimental condition in five different studies. Hudson-Kam (2018) concludes that mimicking infants' learning environment does not facilitate adult learning of a grammatical gender system.

How are we to reconcile these two seemingly contrasting lines of evidence? One possibility is that the studies simply examine different linguistic relations: a "child-like" environment may facilitate learning certain grammatical relations, but not others. This kind of pattern is predicted by experience-based accounts of L2 difficulty: what is facilitative will depend on the relation being learned (see additional discussion of this below). However, the linguistic relations in the different studies share more commonalities than differences. While the studies differ in the presence of phonological cues and the position of the gender marker (prefix vs. suffix),<sup>1</sup> they both test mastery of a non-semantic noun class system, which L2 learners struggle with. Instead, the crucial difference may lie in how the "child-like" environment is defined. In all five experiments, Hudson-Kam defines the experimental condition—where learners hear only sound first—as the more child-like one. The claim is that being exposed first to speech will encourage adults to engage in phonological bootstrapping, which will in turn facilitate noun class learning.

There are several issues, however, with this argument. The first theoretical issue is the relation between phonological bootstrapping, L1-L2 differences, and improved learning of noun classes. Why should exposure to sound alone facilitate phonological bootstrapping and how does it relate to noun class learning? Support for phonological bootstrapping comes from findings showing that infants are highly sensitive to phonological information early on (e.g., Shi, Werker, & Morgan, 1999), and can use it to learn syntactic information (e.g., Gerken, Wilson, & Lewis, 2005; Morgan & Demuth, 1996). However, this literature does not show that such processes are more likely to occur in the presence of sound alone or that they are reduced in adult L2 learners. A separate literature documents children's greater reliance on phonological cues compared to semantic cues in the acquisition of gender classes (e.g., Karmiloff-Smith, 1981), with recent suggestions that this has to do with the order in which these cues are acquired (Culbertson, Gagliardi, & Smith, 2017). However, these findings do not show that reliance on phonological cues leads to better learning, but rather, that when faced with conflicting cues, learners value early-learned cues (phonological) over later ones (semantic). That is, the existing findings do not clearly predict that learners in the experimental condition will be better at learning the noun classes.

The second issue has to do with *how* infant's early experience is mimicked and raises additional questions about whether the experimental condition should in fact promote learning. While infants take a while to learn word meanings (although recent findings suggest they do so earlier than previously thought, Bergelson & Swingley, 2012, 2015), they always hear language in its situated and embodied context. Infants are exposed to speech and meaning simultaneously from the very start. The experimental condition, where learners are initially deprived of meaning, does not seem like a good approximation of infants' early linguistic experience. If anything, the control condition seems more child-like in its simultaneous exposure to sound and meaning, and in the use of natural sentence prosody. That is, the "child-like" environment in these experiments does not simulate aspects of children's early experience that are theoretically predicted to facilitate learning.

This third issue relates to the strength of the results. The effect of condition was not significant in any of the studies, highlighting an additional methodological concern. The effect of condition (in either direction) is hard to interpret when it is based on such a small sample. The five studies had, on average, less than ten participants in each condition (ranging from 8–12, with one experiment having

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<sup>1</sup>Interestingly, both factors may lead to higher overall learning accuracy in Hudson Kam's language compared to previous studies: phonological cues assist adults' learning of noun classes (e.g., Brooks et al., 1993) and suffixes are claimed to be learned better (Ramscar et al., 2010). However, this is orthogonal to the impact of learning environment on accuracy. Having a more child-like environment should still lead to higher accuracy compared to having a less child-like one.

only three participants in the control condition). These numbers are worrying given individual differences in language learning, and the effect of factors like language background on performance in artificial language studies (Finn, Hudson Kam, Ettliger, Vytlačil, & D'Esposito, 2013). This power issue was addressed by Hudson-Kam by analyzing the pooled data from the five studies ( $N = 88$ ) and showing that the effect of condition remained non-significant. However, as Hudson-Kam notes, the studies differed in ways that limit the ability to draw strong conclusions from the pooled data (exposure duration, instructions, Finn, Lee, Kraus, & Hudson Kam, 2014). The author motivates their inclusion of all the manipulations, even those with few participants, as a reflection of their commitment to “the spirit of open science” (Hudson-Kam, 2018 p. 5). However, the important drive towards increased transparency and reproducibility (e.g., Aarts et al., 2015; Nosek et al., 2015), is not aided by the publication of data based on small samples, especially without providing the means and SDs of each condition necessary to do a power analysis.

Another factor complicating the comparison between the two conditions is that they differ not only in the order of exposure (whether participants heard sound only first), but also in the amount of exposure. The control condition was exposed to meanings twice as often as the experimental condition. Manipulating the input in this way means that we cannot know if the difference (or lack thereof) is related to the order or the amount of exposure. This design may have biased the results against the author's hypothesis: the predicted advantage of the experimental condition could have been offset by their reduced exposure to meaning. An alternative manipulation would be to expose the control group to sound + meaning first and then to sound on its own. The importance of manipulating order and not frequency when examining the effect of early input on L1-L2 differences is grounded in learning theory, which demonstrates how what you know crucially impacts subsequent learning (e.g., Ramscar, 2013; Ramscar, Yarlett, Dye, Denny, & Thorpe, 2010). A combination of factors thus makes it hard to evaluate the effect of condition on adults' performance based on these results.

More broadly, the difference in the effect of simulating children's early experience for adult learners between Hudson-Kam (2018) and previous studies (Arnon & Ramscar, 2012; Siegelman & Arnon, 2015) highlights a general challenge in studying L1-L2 differences: The need to move from talking about difficulty with language as a whole to looking at particular aspects of language and why their learning trajectories differ in children and adults. While adults rarely reach native-like proficiency in a second language, they are not equally bad at all aspects of the second language. For instance, adults struggle less with learning vocabulary items and basic word order compared to learning grammatical relations (De Keysar, 2005; Johnson & Newport, 1989). The challenge lies in relating specific learner characteristics to particular learning outcomes: what it is about adults' cognitive make-up or linguistic experience that leads to the specific learning trajectory we see? While neural and cognitive differences contribute to the general difference in proficiency between child and adult learners (Kuhl, 2000; Lenneberg, 1967; Neville & Bavelier, 2001), they cannot necessarily explain why certain aspects are harder than others for adults.

A similar challenge arises when attempting to mimic infant's early experience as a way to enhance L2 learning. Doing so requires clear predictions about which aspects of infants' environment are facilitative, and for which aspects of language. Only then can we successfully test these predictions empirically. To give an example, in the SBH outlined above, children's advantage is related to their greater reliance on multiword building blocks. The aspects of their experience that promote their use are the lack of word boundary knowledge and the simultaneous learning of multiple aspects of language, both of which can be manipulated in adult learners. Importantly, the SBH proposes a mechanism to explain *why* and *when* multiword units are beneficial: learning from them increases the informativity of the grammatical element and its' association with the word/object it modifies (see Arnon & Ramscar, 2012 for a Rescorla-Wagner simulation of this pattern). Consequently, multiword units are not expected to carry an advantage across-the-board, but only in cases where the grammatical element doesn't carry independent semantic information. Indeed, when nouns were classified into classes based on animacy (animate vs. inanimate), there was no advantage for learning

from larger units (Siegelman & Arnon, 2015). Similar specification is needed to motivate the learning advantage hypothesized by Hudson-Kam (2018): we need a clearer definition of when and why phonological bootstrapping will facilitate adult learning (and when it will not), and how it can be manipulated in adult learners.

In summary, Hudson-Kam (2018) presents a thought-provoking hypothesis on the effect of early experience on L1-L2 differences. However, several theoretical and methodological issues undermine the conclusion that mimicking infants' early experience does not facilitate adult learning. The difference between this study and previous ones highlights ongoing challenges in studying adult language learning. A comprehensive and testable account of L1-L2 differences has to include a clear characterization of the aspects of children's experience that facilitate learning, the mechanism by which they do it, and the linguistic features that are predicted to be impacted.

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