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Developmental psycholinguistics teaches us that we need multi-method, not single method, approaches to the study of linguistic representation

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Abstract:	In developmental psycholinguistics, we have, for many years, been generating and testing theories that propose both descriptions of adult representations, and explanations of how those representations develop. We have learnt that restricting ourselves to any one methodology yields only incomplete data about the nature of linguistic representations. We argue that we need a multi-method approach to the study of representation.

Commentary on Branigan & Pickering

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Abstract (60 words)
In developmental psycholinguistics, we have, for many years, been generating and testing theories that propose both descriptions of adult representations, and explanations of how those representations develop. We have learnt that restricting ourselves to any one methodology yields only incomplete data about the nature of linguistic representations. We argue that we need a multi-method approach to the study of representation.

Main text (998 words)
Branigan and Pickering rightly state that acceptability judgments only access linguistic representations indirectly via language comprehension and production processes. This makes it difficult to draw strong conclusions about the nature of representations, since "the data are compatible with particular grammar-processor pairings, not just with particular grammars" (p.14).

However, this problem applies to all methodologies, including priming. In developmental psycholinguistics, we generate and test theories that propose both descriptions of adult representations, and explanations of how those representations develop (e.g. Goldberg, 2006; Pinker, 1984). We have learnt that restricting ourselves to any method – even a well-studied method like priming – yields only incomplete data about the nature of linguistic representation. For example, in priming studies, we access children's linguistic representation through the lens of a still poorly-understood effect of priming on children's sentence production. To interpret our data, we must make inferences about the mechanisms underlying priming, and how these mechanisms use the child's emerging linguistic knowledge. If our inferences about those processes, and how they use linguistic representations, are flawed, the conclusions we draw about representations will be flawed. In other words, if we rely on priming only, we will generate an incomplete theory of linguistic representations, which is likely to fail once tested using different methodologies.

The solution is a multi-method approach. As we have argued in Monaghan and Rowland (in press), by gathering evidence from different methods we can converge on a more holistic understanding of the child's developing representations. Below we illustrate our argument with two examples.

First, we examine how to determine what linguistic representations children hold at different ages. Structural priming studies have been informative here, showing that even young children's syntactic representations are abstract enough to support generalisation across verbs. For example, three-year-old children produce more double object datives (DODs) after a double object dative prime than after a prepositional dative (PD) prime, even when the prime and target sentence share no content words (Peter, Chang, Pine, Blything, & Rowland, 2015; Rowland, Chang, Ambridge, Pine, & Lieven, 2012; see Thothathiri & Snedeker, 2008, for similar results in comprehension).

It is tempting to conclude from this that children's dative representations are not only abstract but adultlike; that "Evidence from these studies suggests that from a relatively young age, children's structural representations are similar to adults'" (Branigan & Pickering: 52). However, although priming studies tell us that children's dative representations are abstract, they are not necessarily adultlike. This would be to assume that the priming mechanism requires adultlike representations, which is yet to be ascertained.

In fact, findings from other methodologies reveal asymmetries in the pattern of PD and DOD acquisition, which suggest that the two are not equally adultlike early on. Although naturalistic studies show that children produce DODs earlier than PDs (Snyder & Stromswold, 1997), early DOD use is restricted to a small set of high frequency verbs (Campbell & Tomasello, 2001). Children are more productive earlier with the PD, in the sense of being more willing to use PD structures in novel verb experiments. For example, Conwell & Demuth (2007) showed that three-year-olds were more likely to generalise a novel verb heard in a DOD to a prepositional form (e.g. to produce *he pilked the cup to Toby* after hearing *I pilked Toby the cup*) than they were to generalise a novel verb heard in a PD to a double object form. There is a similar asymmetry in novel verb comprehension (Rowland & Noble, 2011).

A number of explanations might integrate these findings. Perhaps children's very early double object datives are restricted to a few, frequent verb-specific patterns, which become so entrenched that it remains difficult to generalise the structure to novel verbs, even when

representations become more abstract (Tomasello, 2000). Alternatively, PD representations may have a "head-start on the process of becoming abstract" because of their structural similarity to the early acquired transitive structure (Campbell & Tomasello, 2001: 266). More work is needed here. Our point is simply that without a multi-method approach, we would not gain these insights into the nature of children's developing knowledge.

Our second example demonstrates how a multi-method approach combining computational modelling with experimental work enables us to test the complex interplay between representation and processing of those representations. Distinguishing processing from representation is far from trivial, as defenders of acceptability judgments have indicated (Branigan & Pickering, pp.10-11). Consequently, a theoretical model, as presented by Branigan and Pickering, provides only a first step as a description of representational features, and the likely processes that operate over these representations. Computational modelling of experimental findings is needed to test the necessity and sufficiency of representation and processing in the language system, as well as the extent to which there is separability between representations and the processes operating over them.

Chang, Dell, & Bock (2006) showed that a computational model with distinct event semantics and syntactic knowledge was able to simulate a series of syntactic priming effects, but only when points of interaction between those representations was limited. However, language is acquired and processed in a rich, multimodal situation that goes far beyond the representations described in Chang et al. (2006). For instance, Smith, Monaghan, & Huettig (2017b) constructed a computational model of processing in visual world paradigm tasks, determining how phonological, visual, and semantic representations are integrated during speech perception. They demonstrated that the behavioural data could be simulated most effectively only when these representations interpenetrated throughout processing, rather than assuming autonomy of these representations cohering at the outcome of processing. An extension of this model to language development showed that differences in quantity of exposure to a rich, multimodal language environment was sufficient to simulate child and adult behavioural differences in visual world paradigm tasks (Smith, Monaghan, & Huettig, 2017a). In other words, combining insights from the rich interactivity of multimodal information with the possible advantages of modular processing of this richness requires computational implementations to distinguish alternative accounts.

In sum, the process of determining linguistic representations from empirical data is far from straightforward, and requires a multi-methodological approach.

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