

Waxman and Gelman conclude that these findings are incompatible with the strictly associative account. Why not? Given that the majority of the early nouns are associated with 3D objects and not with pictures (i.e. babies spend more time roaming the world rather than reading picture books), 18-month-olds are likely to have more statistics about word-object associations than word-picture associations. Therefore, there is little surprise that a brief experience fails to override hard learned contingencies and such failure is testimony to the power of associations rather than evidence against it. By contrast, by simply stating that ‘words refer to concepts,’ Waxman and Gelman use *explanandum* as *explanans*.

Although time is crucial in the study of development, it is missing from the Waxman and Gelman argument, thus resulting in an exceedingly static picture of human development. Consider the argument that words refer. For many researchers, reference is neither timeless nor universal, but is a product of development: ‘One might think that it goes without saying that a symbol always represents something ‘other than itself’, but only gradually do infants appreciate how some symbols differ from their referents.’ ([6], p. 68). Although, no full account of the development of reference has been offered yet, several proposals have been put forward about words starting out as features [7,8]. Therefore, if time is taken seriously, then ‘words are features’ and ‘words refer’ could be as non-contradictory as ‘children babble’ and ‘children read’.

The CB account does not dispute the role of data, but argues for the role of theory. However, CB is yet to formulate in clear and testable terms what these theories are,

where they come from, what their components are and how they interact with data. If theories are generalizations over data, then CB account is reduced to the CDA account. However, if the claim is that theories are not derived from data, then the CB account has to specify what the theories are a product of. Progress in understanding cognitive development requires more than metaphors; it requires quantifiable, testable and falsifiable theories.

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#### Letters Response

## Response to Sloutsky: Taking development seriously: theories cannot emerge from associations alone

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In our Opinion piece [1], we articulated four elements of words that are essential to any theory of acquisition. First, words refer, they do not merely associate. Second, word-meanings incorporate abstract conceptual knowledge (e.g. ‘intention’, ‘cause’, ‘animacy’), in addition to sensory and perceptual features. Third, there are different ‘kinds’ of word (e.g. nouns versus verbs), each linked to a different ‘kind’ of concept (e.g. categories of objects versus events). Finally, words acquire their meaning not only from their histories of co-occurrence with entities in the world, but also from the intricate linguistic and social systems of which they are a part. We amassed evidence from several different research programs bearing on each of these points

in children ranging from six months to four years old [2,3] and outlined a detailed developmental trajectory, revealing that conceptual and linguistic capacities are available to preverbal infants and that these become increasingly precise from infancy into the preschool years.

Curiously, although each of our four points is contested in Sloutsky’s theoretical position [4–6], he engaged none of them in his response [7]. Neither did he provide a plausible alternative account of specific findings, including for example, that when infants see a set of objects (e.g. red apples) paired with a novel word, they interpret a novel noun as referring specifically to the object category (e.g. apples) and an adjective as referring specifically to an object property (e.g. red). This finding, and others like it, are at odds with Sloutsky’s

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assertions that (i) words are merely features of the objects with which they have become associated and (ii), words (by virtue of their status as auditory information) evoke so global a response in young children as to overshadow visual information.

Sloutsky [7] raises two objections, both of which miss their mark. First, he criticizes our proposal, which engages evidence from infancy through the preschool years, as insufficiently developmental. Second, he objects that we fail to account for how early theories arise from ‘simpler components’. But we reject the assumption that the infants’ initial framework theories are constructed from simpler units. On the contrary, in our view, initial theories and ontologies (e.g. regarding agency or physical causality) are themselves conceptual primitives, providing strong starting-points in infancy for the more elaborated theories evident later in development. That is, infants establish associations, and make sense of them, within the context of the theories they hold.

How does Sloutsky’s account fare against his own criticisms? He attributes to infants a capacity to build associations and detect perceptual similarities. But strikingly absent is any account of how theories (which he acknowledges are held by children and adults) could emerge from a bedrock of associations alone. Also absent is a principled account of similarity.

In closing, we stand by the developmental portrait we have painted. ‘As infants and young children build a repertoire of concepts and acquire words to describe them,

they [use] both perceptual and conceptual information, and rely upon both the rudimentary theories that they hold and the statistics that they witness.’

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