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Authors

Byers, Patrick

Xu, Fei

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Discourse Analysis as a Solution to Interpretive Problems in Cognitive Development Research

Patrick Byers (Patrick.d.byers@gmail.com)

Department of Psychology, 365 Fifth Ave.

New York, NY 10016 USA

Abstract

Cognitive development researchers have drawn conclusions about young children's developing knowledge of number by studying their behavior, while at the same time acknowledging that behavior is an imperfect index of knowledge, e.g., it may be disputed whether a given behavioral task accurately measures, overestimates, or underestimates children's knowledge. The texts of published research articles from these investigations are the focus of a discourse analysis described in the present article. The results of the discourse analysis suggest that claims about what a person knows are actually generalized descriptions of behavior. Therefore, in studying behavior on tasks to draw conclusions about participants' conceptual knowledge, researchers are merely making behavioral generalizations, not investigating hidden cognitive or epistemic content.

Keywords: conceptual knowledge; discourse; epistemology; performance and competence; conceptual and procedural knowledge

Introduction

Cognitive development researchers have drawn conclusions about young children's developing knowledge of number by studying their behavior, while at the same time acknowledging that behavior is an imperfect index of knowledge. For example, researchers may dispute whether a given behavioral task accurately measures, overestimates, or underestimates children's knowledge, all while tacitly accepting that behavior is what provides proof of knowledge. This ambivalent relationship between knowledge and behavior—knowledge is neither perfectly reflected in behavior, but behavior is the only clue we have as to what children know—has made the distinction between them central to investigations of children's knowledge of number. In fact, many of these investigations are as much concerned with determining valid behavioral indices of that knowledge as with the knowledge itself (Briars and Siegler, 1984; Gelman and Meck, 1983; Greeno, Riley and Gelman, 1984; Rittle-Johnson, Schneider and Star, 2015; Sarnecka and Carey, 2008; Wynn, 1990).

The current paper argues that the distinction between knowledge and behavior as pursued in this research is illusory, and that descriptions of what children know are, in fact, descriptions of behavioral capacities rather than descriptions of some hidden, epistemic content. This conclusion is supported by the results of a qualitative discourse analysis of the ways that claims about what

children know are justified, negotiated and contested in research articles on early number concepts.

Knowledge and Behavior in Research on Cardinality

Research on developing number concepts in children has focused extensively on their understanding of the cardinal meanings of number words and counting, or cardinality. Cardinality refers to the way that number words denote entire sets of items, rather than merely the individual members of those sets. Part of the reason for this focus on cardinality is that children are inconsistent in performing the behaviors indicative of understanding cardinality. Children who are otherwise able to use numbers in various ways (e.g., in counting) often fail to demonstrate an understanding of cardinality in certain contexts. For example, Fuson (1988) describes preschool children who, after accurately counting a set of five items, and responding to the question "how many are there" with the last counted word (a behavior ostensibly indicative of understanding cardinality), respond to the request for *the five items* by picking up only the fifth counted item. Other studies report similar findings. For example, when asked to create a set of a requested number of items from a larger pile, preschool-aged children who were otherwise proficient counters responded by grabbing a random (numerically unrelated) number of items (Fuson, 1988; Sarnecka & Carey, 2007; Wynn, 1990).

Researchers interpret these types of inconsistent displays of competence by recourse to two acknowledgements about the relation between knowledge and behavior: (1) First, it may be claimed that competence precedes performance, i.e., young children may understand cardinality but have difficulty planning and/or executing actions that reflect this understanding (e.g., Gelman and Gallistel, 1978). (2) Alternately, it is claimed that performance may precede competence, i.e., young children's apparent competence in some contexts may reflect their carrying out rote-learned or imitated behavioral routines that they do not yet fully understand on a conceptual level (e.g., Wynn, 1990).

These interpretations allow researchers to provide stable accounts of children's developing conceptual knowledge of number, despite inconsistent and unpredictable behavioral performances. Yet, as has been explained in more detail elsewhere (Allen & Bickhard, 2013; Byers, 2016), the flexibility that these explanations provide is inherently problematic. If we accept that (1) knowledge can be present despite the absence of corresponding behavior, and (2)

behavioral performances ostensibly indicative of knowledge may be performed in the absence of that knowledge, this means that essentially any behavioral evidence can be consistent with any underlying conceptual knowledge. This is especially problematic because, in the previously cited research, behavior is the only available predictor of knowledge. It is not clear how the additional study of children's behavior could produce more definitive conclusions about children's knowledge of cardinality.

The current paper proposes that the fundamental issue here is not one that can be resolved by further study of children's behavior. Instead, the crucial issue is that the distinction between behavior and knowledge—and specifically the attempt to draw conclusions about knowledge on the basis of behavioral evidence, while simultaneously treating behavior as an ambiguous indicator of that knowledge—undermines the discursive practices through which conclusions about knowledge are normatively reached. These arguments are elaborated in the following sections, which describe a discourse analysis of the texts of research articles that report conclusions about children's knowledge of cardinality.

Discourse Analysis of Knowledge Claims

The discourse analysis focused on the ways that conclusions about what children know are asserted, justified and contested in research articles on children's knowledge of number. The aim of this analysis is to develop a general model of how this occurs that can shed light on what it means to claim that the child *knows* or *understands* something about cardinality or number, and why certain types of evidence provide grounds for asserting or contesting these claims. These issues are important since, insofar as problems in reaching conclusions about children's knowledge of number stem from (or can be understood in terms of) the discursive practices themselves, the most relevant aspect of these practices are the conclusions about knowledge, and their justification.

Sampling of Texts

The discourse analysis was conducted on a sample of ten published research articles,¹ each of which was focused on children's conceptual knowledge of number. In each of these articles, claims are made about what children do/don't know, which are justified with evidence and other arguments. The decision to focus only on articles on numerical knowledge was intended to reduce the scope of analysis for purposes of simplicity. While some of the articles have the same authors, and are therefore not discursively independent of each other, the intention of this

¹ The selected articles include Briars and Siegler (1984), Brooks, Audet and Barner (2012) Davidson, Eng and Barner (2012), Frye, Braisby, Lowe, Maroudas and Nicholls (1989), Gelman (1972), Gelman and Meck (1983), Nikoloska (2009), Sarnecka and Carey (2007), Sarnecka and Wright (2013), Sophian (1988), and Wynn (1990).

study was not to construct a representative sample of all published research in this area, but to understand, in depth, the way that knowledge claims may be asserted/contested/justified in a specific discursive context, with the hope that this may yield findings applicable to other discursive contexts. While it is possible that the current results will not be generalizable due to idiosyncratic features of the sample, this kind of high density sampling allows for a comprehensive analysis that would be unwieldy with a broader sample (in a similar way, a historian might claim that an in-depth study of a particular war (from a few extensive accounts) might yield in-depth knowledge about war that would not be possible from a more brief study of many accounts). Consequently, while the current results must be taken as only potentially generalizable, the hope is that they may illustrate general insights about how conclusions about knowledge are reached.

Process of Analysis

As a starting point for the analysis, a preliminary distinction was made between two types of statements to be identified in each of the texts: *knowledge claims*, and the statements that justify them—*justifications* (both are described in detail below in Table 1). These initial categories were necessary as a starting point for the analysis, which after all, cannot come from nowhere. In the remainder of this article, examples of knowledge claims will be italicized and justifications will be underlined.

Knowledge Claims Knowledge claims are assertions of what a person knows. They are not just any claims about knowledge, but rather claims that describe what is known. Knowledge claims most commonly involve the verbs *to know* or *to understand*, but may also use others such as *realize*, *recognize*, or phrases such as the claim that a person *has a concept of something*. A basic example of a knowledge claim is the following: *s/he understands the cardinal meaning of the number six*. Knowledge claims may also be assertions that a person does *not* know something, e.g., *s/he does not understand the cardinal meaning of the number six*.

Justifications Justifications are the most directly given reason used to support or contest a given knowledge claim. Continuing from the example above, the justification would be the reason or proof given for the assertion of the previous statement. For example if it is claimed that *s/he understands the cardinal meaning of the number six* because s/he correctly gives out six items from a larger pile when requested, the latter underlined portion would be a justification. As this description implies, justifications can only be identified relative to a knowledge claim, rather than in terms of the intrinsic characteristics of the justifying statement itself.

Table 1: Composite statements containing *knowledge claims* (italicized) and justifications (underlined).

S/he doesn't understand how counting works because when asked for "four toys" from a larger pile, she responded by grabbing a random number of toys.

The concept of cardinality is measured by performance on the Give-N task.

*After an experimenter removed an item from a previously counted set, the child correctly responded when asked how many items it now contained, suggesting that *s/he knows the subtraction of an item from a counted set means that the number of items in the set decreases by one.**

Identification of Knowledge Claims and Justifications in the Analyzed Texts

While Table 1 shows knowledge claims and justifications as relatively discrete features in the text, it was recognized that instances of each may only be interpretable as a distributed network of connected statements across a text (e.g. descriptions of a task performance elaborated in multiple separate sections). In addition, the analysis focused on explicitly-, implicitly- and conditionally-asserted knowledge claims/justifications. Finally, care was taken to ensure that knowledge claims/justifications were identified in cases where, due to the flexibility of language, they may not have been apparent as such. For example, although the phrase *children's invariance schemes contain rules for reversing operations* (Gelman, 1972, p. 84) is not immediately apparent as a knowledge claim, it was classified as such because, in context, it clearly meant children *know that addition and subtraction (but not displacement) change the numerosity of a set and they also know which operation is needed to reverse the effects of addition/subtraction to return a set to its original numerosity.*

Refinement of Analytical Categories

The analysis proceeded by first reading each text and identifying paired exemplars of *knowledge claims* and *justifications* therein. These paired exemplars were then juxtaposed, revealing common characteristics of each type of statement, as well as clues as to how and why each member of a pair relates to the other. These features were analyzed with the intention of addressing the following questions: What is it about a knowledge claim and its accompanying justification that allows the latter to provide valid grounds for the assertion of the former? In cases where a justification is brought in to contest an asserted claim, what is it about the justification/claim that makes it possible for this to be done? More generally, under what circumstances can previously-justified knowledge claims be contested, and how is this done? Tentative answers to these questions were scrutinized by assessing the extent to which

they were consistent with the broader use of knowledge claims throughout the sampled texts.

Results

The analysis of the selected texts in terms of the above categories (knowledge claim and justification) produced a variety of results. A full presentation of all of these is beyond the scope of the present paper. For the current purposes, the following two results are the basis for the most significant findings of the study.

Similarity of Knowledge Claims and Justifications

The distinction between knowledge claims and justifications was readily apparent in the analyzed texts. However, this distinction appeared to be a relative one, rather than something that could be defined in terms of the intrinsic characteristics of statements exemplifying either category. While this was assumed from the beginning to be true for justifications, the discourse analysis showed it to be true for knowledge claims as well (i.e., a statement is only a knowledge claim relative to the surrounding text).

While certain types of statements were found to be more typical of either knowledge claims or justifications (statements using verbs like *know* or *understand* versus descriptions of behavioral performances), these characteristics did not reliably characterize statements of either type because there was no type of statement that was exclusively found in only one category or the other. So, while assertions that a person *knows X* or *has a concept of X* were more typical of knowledge claims, statements like these were occasionally used as justifications. This is evident in the following quote from Frye et al. (1989), in which a description of what a child knows (first sentence) is presented as the possible justification for two alternative knowledge claims:

...[the child's knowledge] that the cardinal value reached on the second trick trial ought to be the same as on the first correct trial. That knowledge could be evidence of [an understanding of] cardinality, or of a less specific understanding that if nothing about the array changes, the puppet's response shouldn't change either. (p. 1168)

Similarly, although descriptions of a person's behavior were more typically associated with justifications, these sorts of statements were occasionally used in essentially the same way as knowledge claims, insofar as their assertion was justified by other statements. (Despite not involving words like *know*, *understand*, etc., for reasons that will become clear, these statements can still be considered to be knowledge claims.)

There were also cases in which a statement appeared to simultaneously function as a knowledge claim and justification. This is evident in the following quote from Gelman (1972)

Together, the reactions to Phase III indicate the children treated subtraction as an operation that was relevant and displacement as one that was irrelevant to number. This

indicates they had the ability to treat number (at least small ones) as invariant. ...

Reactions to the surreptitious changes introduced in Phase III indicate that Ss treated addition as relevant and displacement as irrelevant to number. ...The means of 1.5 and 0.3 reflect the fact that 15 addition and only four displacement Ss were surprised by the changes. All addition Ss noted the change as opposed to only six displacement Ss. (Gelman, 1972, p. 8)

In the quote, the phrase *children treated subtraction as an operation that was relevant and displacement as one that was irrelevant* functions as a justification for the claim that *children had the ability to treat number as invariant*. It also functions as a knowledge claim that is justified by the final two sentences of the quote.

The absence of a clear distinction between the intrinsic characteristics of statements serving as knowledge claims as opposed to justifications becomes even more apparent if we juxtapose a variety of examples of knowledge claims and justifications. In the place of clear boundaries between the two categories, a continuum emerges. As a demonstration of this, consider the following list of quoted knowledge claims and justifications, culled from the Davidson, Eng and Barner (2012, p. 162-162). Within those two pages, the authors entertain whether children...

- ...understand how counting represents cardinalities.
- ...have the meanings for only a subset of the words in their count list.
- ... understand that...when a set beyond the child's counting range has an item removed and replaced with a different item...it retains its cardinality and that the same number word applies.
- ...are able to distinguish one and two from each other and from the rest of the numbers in their count list.
- ...are more likely to respond correctly when asked if there are now six or seven objects.
- can recite higher numbers (e.g., 5 or 10) [when counting]

The list begins with statements classified as knowledge claims and ends with justifications. While statements on either extreme are clearly distinct, no clear demarcation point between them is apparent. These findings will be further addressed in the interpretation section below.

Researchers' Responses to Inconsistent Evidence

The second relevant finding involved the fact that, at various points in each of the analyzed texts, authors gave reports of inconsistent evidence for a particular knowledge claim. This inconsistency involved findings that the same child would succeed and fail on two tasks that were (ostensibly) measures of the same form of knowledge. One example is summarized by Brooks, Audet and Barner (2012):

Previous studies report conflicting evidence, and find that children expect numerals to label precise quantities in some tasks but not in others" (Sarnecka and Gelman, 2004; Condry and Spelke, 2008). (p. 1066)

In the terminology of knowledge claims and justifications, the above quote can be rephrased as saying 'previous researchers have found the same children's behavior across multiple tasks to constitute justifications for and against the knowledge claim that children *expect numerals to label precise quantities*.' Brooks et al. (2012) resolve this inconsistency by arguing that "some of children's apparent successes are best explained not by domain-specific semantic understanding of number, but instead by language-general pragmatic abilities" (p. 1066). This argument, like others seen throughout the analyzed texts, resolves inconsistent findings by re-describing some of the knowledge claims made on the basis of observed behavior. In this case, a behavioral performance ostensibly indicative of conceptual knowledge of number is re-described as indicative of general pragmatic abilities. Such arguments appear to work by differentiating the conflicting evidence, thereby removing the apparent inconsistency.

Interpretation of Results

The above findings suggest the following interpretations of what knowledge claims and justifications are and how they function:

1. Knowledge claims and justifications are both descriptions of behavioral dispositions.
2. A justification is a more concrete description of some aspect of the behavioral disposition that is described more generally by the knowledge claim.

The ways that these conclusions were derived from the previous two findings is explained in the following sections.

Knowledge Claims and Justifications are Descriptions of Behavioral Dispositions

The idea that knowledge claims and justifications are both descriptions of behavioral dispositions explains the similarity between both types of statements, as well as they ways they were used. This interpretation also makes intuitive sense in the case of most justifications, insofar as these were very often descriptions of behavioral performances. It makes less intuitive sense in the case of knowledge claims, which do not obviously appear to be descriptions of dispositions. Nevertheless, the idea that knowledge claims (including descriptions of very abstract conceptual knowledge, e.g., *understanding the cardinal principle*) are descriptions of behavioral dispositions is strongly supported by a variety of findings. To illustrate this, consider a typical case in which a knowledge claim is justified by a description of some behavioral performance, e.g., *knowledge of the cardinal principle* is justified by the fact that a child was able to accurately create sets of a requested number of items. (Although not all justifications were self-evidently descriptions of behavior, this explanation will account for those other cases as well.) If knowledge claims are themselves descriptions of behavioral dispositions, this explains (1) how researchers determine the particular behavioral performance denoted by the justification as relevant to the knowledge claim, and (2) why

the performance of the behavior described by the justification would be grounds for (or at least consistent with) the assertion of the knowledge claim. For similar reasons, this explanation also accounts for why descriptions of behavioral performances were sometimes used in the same way as knowledge claims, as well as cases in which knowledge claims were justified by other claims about what children know: Since—according to the current interpretation—all knowledge claims and justifications are descriptions of behavioral dispositions, these exceptional cases are not fundamentally unique.

The fact that knowledge claims for conceptual knowledge (e.g., *knowing the cardinal principle*) don't often appear to be descriptions of behavioral dispositions may be a reflection of the generality of the described disposition. While any disposition implies some range of behavior, rather than only one specific behavioral performance, this range may be more broad or narrow in different cases. It is relatively narrow in the case of a disposition such as *knowing how to recite a particular poem*, and much more broad in the case of a disposition like *understanding that poem*. In the former case, there would be clear structural resemblances in the range of behavior instantiating the described disposition. In the latter case, the disposition would be instantiated by a broad variety of behavioral forms whose similarity to each other may only be very abstract.

Knowledge Claims and Justifications as Relative Levels of Abstraction

Descriptions of behavioral dispositions do not describe specific behaviors, but rather a potential for some variety of related forms of behavior. Dispositions can be described at varying levels of abstractness/concreteness, with more concretely described dispositions denoting only highly structurally similar forms of behavior, and more abstract dispositions denoting forms that may share only a very abstract similarity. For instance, the disposition of a person to *count in general* is instantiated by a wider range of behavior than is the disposition to *count a set of five marbles*.

Descriptions of behavioral dispositions (knowledge claims) at different levels of abstraction can be nested hierarchically if the more abstract claim subsumes the disposition described by the more concrete one. Within such a hierarchically nested set of dispositions, the truth of a more general claim can be used to deductively infer the truth of a more concrete claim subsumed under it (e.g., *if a child knows how to count, they should be able to count these marbles*). Likewise, the truth of more concrete claims can be used to inductively infer the truth of a more abstract one (e.g., *the fact that the child can count marbles suggests that they may be able to count in general*).

The possibility of nesting disposition descriptions, and the inferential possibilities that are possible across different levels of abstraction explains how certain statements justify knowledge claims, and how a given knowledge claim

provides a basis for expectation of more concrete forms of behavior. When researchers study children's behavior to make conclusions about what they know, they are in fact assessing whether a general disposition can be inductively inferred to be true as a function of whether the specific behaviors (or sub-dispositions) that it entails are in fact observed. Failure to observe these forms of behavior provides grounds for the rejection of the knowledge claim.

The view being developed here also accounts for the problems and solutions that emerged in cases of inconsistent evidence (i.e., finding that a child can perform some but not all of the forms of behavior implicated by a given knowledge claim. If knowledge claims are descriptions of more general dispositions (relative to their justifications), then to assert them is to imply a variety of more concrete dispositions subsumed under the asserted claim. The finding of inconsistent performance of these subsumed behaviors is problematic vis a vis a given knowledge claim, since this permits neither assertion nor rejection of the more general claim. Consequently, it is understandable that, in these instances, researchers tended to re-describe one of the inconsistent performances, since this had the effect of removing it as an exemplar of an inconsistently supported, knowledge claim, and resulting in a now-consistent body of evidence for or against the assertion of the knowledge claim.

This can be shown with the following example. If a child passes all but one task measuring an *understanding of the cardinal principle*, the researcher may claim that the failed task (behavior X) was too difficult due to, e.g., memory demands. In doing this, the researcher is effectively re-describing task X as not only a measure of the cardinal principle, but additionally as a measure of memory ability. The fact that the task has now been claimed to also measure memory ability means that it is no longer a valid concrete instantiation of *understanding the cardinal principle*. Consequently, the child can now be claimed to *understand the cardinal principle* because this no longer implies passing task x, since the latter is now a justification for a claim along the lines of: *demonstrating knowledge of the cardinality principle in a context that involves excessive memory demands*.

Conclusion

The present research analyzed the texts of published research articles in order to explain how conclusions about children's knowledge of number are asserted, justified and contested, as well as how these statements function and what they indicate. The premise for this investigation was the observed difficulty that researchers have faced in drawing definitive conclusions about children's knowledge on the basis of their behavior. The results of the discourse analysis suggest that descriptions of children's knowledge are in fact generalized descriptions of their disposition for certain behavior, and that these knowledge claims are asserted contingent on the observation of behavioral

performances that concretely exemplify certain aspects of the behavioral disposition in question.

These conclusions readily account for why cognitive development researchers have been unable to disentangle children's conceptual knowledge from their performance capabilities. From the perspective of the current findings, such a differentiation is impossible. Conceptual knowledge in some conceptual domain is not some cognitive or epistemic entity that is reflected in—but separate from—certain forms of behavior. Rather, it is a discursive generalization of that behavior. Therefore, the perennial discussion of whether children's conceptual competence in some domain chronologically precedes or follows their behavioral ability in that domain is ultimately incoherent.

The centrality of the competence and performance distinction in cognitive development (e.g., in seminal writings such as Chomsky (1965) and Gelman and Gallistel, (1978)), as well as in the use of related distinctions such as that between procedural and conceptual knowledge (Rittle-Johnson & Schneider & Starr, 2015) likely reflects researchers' desire to distinguish between the hidden potential for certain forms of nervous system functioning and the potential for certain forms of overt behavioral performance. While a distinction along these lines is certainly useful for many purposes, the present results suggest that the nervous system capacities in question cannot usefully be characterized in terms of knowledge claims, since insofar as the latter are descriptions of behavior, they cannot realistically be distinguished from behavioral performances.

Future Questions

It cannot be denied that the behavior of any typical person entails actual, rather than just described, patterned behavioral capacities (these might be described as attractor states, such as the stable limit cycle seen in walking, or the tendency towards walking as a solution to the desire to move). Without a doubt, the quasi-predictability that such patterns provide is a prerequisite for the utility of any generalizations about behavior (e.g., knowledge claims). To the extent that knowledge claims have predictive power, a crucial question for future research is how and why the dispositions described by knowledge claims correspond in any isomorphic way to these actual dispositional capacities of the typical human organism.

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