The What and How of Counting

C. R. Gallistel

and

Rochel Gelman

University of Pennsylvania

and

University of California, Los Angeles

The work by Shipley and Shepperson is an important contribution to our understanding of how the world is parsed for the purposes of counting. We take this opportunity to correct a common misunderstanding of our so-called "abstraction principle" and, more importantly, to explain why we do not believe the domain-general model for the development of counting proposed by Shipley and Shepperson is a viable alternative to the kind of domain-specific model we have argued for (Gelman & Gallistel, 1978).

In retrospect, we should not have grouped our comments about the inherent lack of restrictions on what might be counted under the heading of the the abstraction principle. What we meant to call attention to was that the principles that inform the process of counting--the principles that define what are and are not valid instances of counting--do not specify attributes of the entities to be counted. The counting principles no more restrict what it is that may be counted than the diagram for a counting mechanism restricts the sorts of things the mechanism may be used to count. It was necessary to stress this at the time because previous accounts of counting had claimed that strictures about counting homogeneous items were part of the young child's understanding of what counting was inherently about. As the Shipley and Shepperson research shows, this is clearly not the case.

We did not mean to imply that nothing biases the child's choice of what to apply its counting process to. On the contrary, we emphasized then our belief that what the child was disposed to count was things--not homogeneous things, just things. From one point of view, the category 'thing' is highly abstract, because it is hard to say

what sensory attributes are common to all things. From another point of view, which we think is more appropriate, the concept of a thing is as basic and primitive a concept as one can specify (Spelke, 1988). We welcome the empirical support the work of Shipley and Shepperson provided for this point of view. We agree that the disposition to recognize the thinginess of the world is a very general one that is in no way restricted to the domain of counting and numerosity, although it is probably a prerequisite for the recognition of numerosity. We are skeptical, however, that the thinginess of the world is much more salient to a human infant than it is to a chimpanzee.

Our reservations about the domain-general account of the development of counting offered by Shipley and Shepperson is that it takes no account of the complementary relation between counting and arithmetic reasoning, both of which appear to be present and interrelated from a very early age. Both counting and arithmetic reasoning also appear to be routine in nonverbal animals, including the chimpanzee, the rat and the pigeon (Boysen and Berntson, 1989; Capaldi and Miller, 1988; Church and Meck, 1984; Fernandes, and Church, 1982; Gallistel, In press; Gallistel, 1989; Meck and Church, 1983; Pepperberg, 1987; Rilling, 1967; Rumbaugh, Savage-Rumbaugh, and Hegel, 1987). Counting provides representatives of numerosity (numerons) for use in arithmetic reasoning (combinatorial and relational operations with representatives of numerosity). Counting must be constrained by principles which insure that the representatives of numerosity generated by the behavior of counting can in general be validly employed in

arithmetic reasoning. For example, the stable-order principle in counting is necessary to insure that when, in the course of arithmetic reasoning, one numeron is reckoned as greater than another, the set whose numerosity is represented by the first numeron is more numerous than the set whose numerosity is represented by the second.

If there is not this complementary relation between the principles that inform the counting process and the principles that inform the mechanisms of arithmetic reasoning, then arithmetic reasoning cannot be validly applied to the world. The general dispositions suggested as the source of counting behavior would not seem to constrain counting in the requisite way. Although the general disposition to pair two sets of dissimilar entities exhaustively (e.g., dolls in rings) can support the constraints of the one-one counting principle, it is neither necessary nor sufficient for counting (Gelman & Greeno, in press). Children count when they have no set of objects to touch -- exhaustively or otherwise. They readily pair many different dolls with identical rings in the course of one episode, and they just as readily pairs many different dolls with the same label "doll" when the focus is on labelling. They fortunately do not pair many successive dolls with the same numeron ("one, one, one") in the course of a single count.

The suggested general dispositions are equally as incapable of insuring the stable ordering in the use of counting terms and of insuring that the final term in the series is used as a representative of the numerosity of the whole set. Appeals to the imitation of adult models will not fill the void, because adult behavior provides

conflicting models. We spent hours playing a game with our toddler son in which we or he pointed to a step and said, "a step", then pointed to the next step and said "another step", and so on, until all the steps had been exhaustively paired with the same label. On the domain general model, the question is, Why did he not think he was counting, that the numerosity of the set of steps was one, and that the English for one was another step?

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