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Magnitude and Order are Both Relevant in SNARC and SNARC-like Effects: A Commentary on Casasanto and Pitt (2019)

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Abstract

In a recent paper by Casasanto and Pitt (2019), the authors addressed a debate regarding the role of order and magnitude in SNARC and SNARC-like effects. Their position is that all these effects can be explained by order, while magnitude could only account for a subset of evidence. Although we agree that order can probably explain the majority of these effects, in this commentary we argue that magnitude is still relevant, since there is evidence that cannot be explained based on ordinality alone. We argue that SNARC-like effects can occur for magnitudes not clearly characterized by overlearned ordinality and that magnitude can prevail on order, when the two are pitted against each other. Finally, we propose that different interpretations of the role of order and magnitude depend on the interaction of stimulus properties and task demands.

Keywords: Magnitude; Ordinal sequence; SNARC; Space; Stimulus-Response Compatibility

1. Introduction

Cognitive research has widely investigated how humans organize information in their minds. For instance, both numbers and other ordinal sequences (e.g., letters) are found to be spatially organized from left to right, depending on the compatibility between the properties of stimuli and responses. This compatibility determines a facilitation in response execution.

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One of the most investigated phenomena within this area is the spatial-numerical association of response codes (SNARC) effect (Dehaene, Bossini, & Giraux, 1993), which consists of faster response execution for small numbers with a left key, and for large numbers with a right key.

In a recent work, Casasanto and Pitt (2019) addressed a longstanding debate in the field; namely, whether the SNARC/SNARC-like effects are driven by the stimuli's order or magnitude (two features that are confounded in numbers). They suggest that ordinality alone would be sufficient to produce all SNARC and SNARC-like effects, thus rejecting any role of the magnitude. This statement is based on two assumptions: (1) SNARC-like effects are found also for ordinal stimuli that do not vary in magnitude, (2) when one is pitted against the other, ordinality prevails on cardinality.

Although we agree that ordinality can explain the majority of these effects, in this commentary, we show that there is empirical evidence that cannot be accounted for in terms of ordinality, suggesting that magnitude can still influence these phenomena.

2. SNARC-like effects can occur for magnitudes without (overlearned) ordinality

Casasanto and Pitt (2019) are correct in saying that ordinality alone can determine SNARC-like effects (Gevers, Reynvoet, & Fias, 2003). However, they do not report that SNARC-like effects can also be elicited by stimuli that do vary in magnitude but are not clearly characterized by ordinality.

For example, Fumarola et al. (2014) found a SNARC-like effect for luminance, which is a continuous magnitude that is not commonly experienced as an ordinal sequence and cannot be considered an overlearned set of stimuli (different from numbers or letters). While the results of the direct comparison task (Experiment 1) could be interpreted in terms of ordinality, those of the hue classification task (Experiment 2) are difficult to interpret without taking magnitude into account. Although it could be argued that participants might automatically organize the entire set of stimuli (12 items) in an ordinal manner in working memory, we think that this is unlikely because of the well-known memory limits.

Another example of a SNARC-like effect elicited with a large set of stimuli can be found in a study by Sellaro, Treccani, Job, and Cubelli (2015). Participants had to categorize pictures or words of either animals or inanimate objects. Despite the set consisting of 48 stimuli, a SNARC-like effect was found for the items' typical size, regardless of the task (direct or indirect) and stimulus formats. In this example, it is hard to believe that the entire set of stimuli can be organized in an ordinal manner in working memory. Similar to Fumarola et al. (2014), the results of the indirect task used by Sellaro et al. (2015) are necessarily due to magnitude.

Furthermore, compelling evidence that magnitudes can be spatialized without being accounted for ordinality can be found in animal studies (Lazareva, Gould, Linert, Caillaud, & Gazes, 2020; Rugani, Vallortigara, Priftis, & Regolin, 2020). For example, Rugani, Vallortigara, Priftis, and Regolin (2015) showed that 3-day-old domestic chicks spontaneously associated smaller numerosity (two dots) with the left space and larger numerosity (eight dots) with the right space, after familiarizing with a target numerosity (five dots). Interestingly, the

same eight dots were associated with the left space when the familiarization numerosity was 20, demonstrating that this association depends on the numerical range, resembling what is usually observed in the SNARC effect (Dehaene et al., 1993). Additionally, human neonates (55-h-old) associate small numerosity with the left space and large numerosity with the right space (Di Giorgio et al., 2019), showing the same numerical range flexibility previously observed in newborn chicks. Together this evidence suggests that spatial-numerical associations originate from pre-linguistic and biological precursors that can hardly be accounted in terms of ordinality, which is culturally acquired.

3. Cardinality can prevail on ordinality

Casasanto and Pitt (2019) state that "In the few experiments that have pitted these two hypotheses against each other, the results show a spatial mapping of ordinality" (p. 3). However, all the examples cited by the authors use numbers as stimuli (e.g., van Dijck & Fias, 2011), but in numbers, order and magnitude are confounded.

To disambiguate them, Prpic et al. (2016) employed musical note values–which symbolically represent notes' duration–instead of numbers. Interestingly, musical note values are typically represented in the reversed order to numbers: Number sequences progressively increase in magnitude (from the smallest to the largest), whereas note values decrease in magnitude (from the largest to the smallest).

By testing expert musicians, the authors found a SNARC-like effect resembling the ordinality of the stimuli in the direct task (Experiment 1) and a reversed pattern–in line with the magnitude of the stimuli–in the indirect tasks (Experiments 2 and 3). The latter results clearly contrast the idea that the ordinal properties of the stimuli could drive the direction of the effect since it was reversed, compared to the canonical order used to represent musical note values. Hence, this evidence can only be explained in terms of magnitude.

Therefore, both ordinality and cardinality seem to be able to independently drive SNARC-like effects based on specific task demands: When a direct comparison is required, participants seem to use the ordinal representation of the stimuli to perform the task, while in the case of indirect tasks, the role of stimuli's magnitude seems to drive the effect. In the latter case, cardinality prevailed on ordinality.

4. Conclusion

In our opinion ordinality might be: (1) elicited by the stimuli's properties, (2) induced by the task. As for the first point, it is undeniable that some types of stimuli are clearly defined by ordinality (e.g., letters), while others are not (e.g., luminance). As for the second point, some tasks require participants to directly compare the stimuli with a reference (e.g., magnitude classification/comparison), thus inducing participants to base their judgments on ordinality (as suggested also by Pitt & Casasanto, 2020); while other tasks require participants to process features of the stimuli that are not related with magnitude/order (e.g., hue classification), making ordinality irrelevant to solve the task. In those experiments in which ordinality is

emphasized neither by the stimuli nor by the task, the magnitude would have a higher chance to drive SNARC/SNARC-like effects.

To conclude, both ordinality and magnitude are relevant for the organization of information in our minds. While ordinality is culturally acquired and shaped by experience; magnitude seems to rely on innate cognitive properties. Thus, both cultural and innate mechanisms would regulate spatial-numerical associations, and future studies should further disentangle their contributions.

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