Promised contribution to an *Analysis* symposium on Laurence and Margolis's (2024) *The Building Blocks of Thought* (OUP)

Three brands of concept nativism

Sam Clarke (sam.clarke@usc.edu) & Alexis Wellwood (wellwood@usc.edu)

The Building Blocks of Thought is a long but rewarding book, presenting what may be the most sophisticated and sustained defense of concept nativism currently available on the market. As committed nativists ourselves, we find it to be an important contribution that should now serve as essential reading on the topic. However, given its stated aim of providing a sophisticated and sustained defense of *concept nativism*, readers may be surprised to find that Laurence and Margolis (henceforth L&M) remain remarkably non-committal on the question of which concepts, if any, are innately hardwired. After a brief overview of relevant issues, we focus on number concepts – a case study that appears several times throughout the book – to clarify in what sense the authors might take these concepts to be innate. We find that while L&M appear to vacillate between two distinct, yet comparatively modest brands of nativism about number concepts, they might do better to endorse a third which they have so far neglected to seriously consider.

1. How L&M understand concept nativism

L&M's reluctance to commit on the question of which human concepts, specifically, are innately hardwired is not an oversight. A key thesis of their book is that focusing on questions like this only serves to artificially narrow and simplify the nativist position. In the end, they propose that nativists can rest content with the view that concept acquisition is structured by innate mechanisms of an appropriate variety, irrespective of whether the associated concepts are, themselves, innately hardwired.

On L&M's view, concept nativism is thus consistent with a view on which the relevant concepts are *learned*, provided that this learning is facilitated by the right kinds of mechanism. Such nativism holds merely that conceptual development results from the operations of myriad innate, domain specific mechanisms, each functioning to enable and constrain the acquisition of concepts in their domain – for example, mental state concepts might be acquired from dedicated theory of mind mechanisms, animal concepts from domain-specific folk biology mechanisms, and so on. The contrasting, empiricist position holds that concepts are acquired by way of *domain general learning mechanisms*, such that concepts in one domain (BELIEF, DESIRE) can generally be learned via the same general-purpose mechanisms as those in others (DOG, CAT).

Much helpful ink is spilled to make this view more precise. An important idea that L&M introduce is that of an *acquisition base*: the collection of psychological structures which are *psychologically primitive* in the sense of not having been acquired via learning or any other psychological process. An organism's acquisition base comprises its innate psychological resources, irrespective of whether they are present at birth, written in their genetic code, or dependent in some way upon interaction with the environment (e.g., Samuels 2002; 2004). To make sense of why, for example, animals but not rocks *learn anything at all*, both nativists and empiricists must posit an acquisition base of some sort; what differentiates the empiricist and the nativist is just in what they expect this acquisition base to include. L&M's nativist expects it to contain myriad special purpose mechanisms, each directed at some proprietary domain; the (hardline) empiricist expects it to contain merely basic sensory capacities plus a domain-general capacity for learning.

Distinguishing the acquisition base in this way admits of a spectrum of views. One can be *more* or *less* nativist in virtue of positing *more* or *fewer* special purpose mechanisms, or by positing special purpose mechanisms directed at *narrower* or *broader* conceptual domains. L&M's point is just that nativists needn't deny that concepts are learned through experience: concept nativism obtains for a given domain provided that (a) the relevant concepts are indeed part of the organism's innate acquisition base, or (b) they are learned/acquired via learning mechanisms therein that are specifically directed at the relevant domain.

Some might question whether option (b) truly deserves to be described as *concept nativist*. In what follows, we are happy to accept L&M's framing of the issue, noting that it correctly distances classical empiricism from nativist-leaning theorists like those which posit domain-specific systems of core knowledge. Nevertheless, we detect at least two complications when applying the proposal to debates between L&M and their opponents.

One complication is that the idea of being *psychologically primitive* – and hence proprietary to the acquisition base – is vexed, owing to disagreements over how we should draw a distinction between psychology and other levels of scientific explanation (Fodor 1974; Samuels 2004: 139). Pending a satisfactory characterization of this distinction, nativists of the ilk suggested by L&M risk talking past their opponents.

To illustrate, suppose we follow Fodor and Pylyshyn (1988) in holding that neural networks fail to provide plausible accounts of human cognition; at most, such models offer insight into how a classical cognitive architecture is implemented at an autonomous, sub-psychological level of (neural) analysis. If so, this problematizes the idea that a psychologically primitive acquisition base is innate in the ways that contemporary empiricists, who increasingly avail themselves of advances in neural network architectures, will reject. That is, card-carrying empiricists would reasonably find their position vindicated if all of the following were true: neural networks are capable of acquiring new representational primitives, flexibly shaped by "experience" (e.g., Nasr et al. 2022), via non-classical operations that, arguably, bear a striking resemblance to the empiricists' cherished mode of concept acquisition by "abstraction" (Buckner 2018; c.f. L&M Ch.5). If so, L&M's nativist could seem to have changed the subject: given the autonomy of psychology from neural network-based implementation, novel concepts flexibly acquired via neural network-based abstraction will wind up components of the system's/organism's innate acquisition base, on account of having been acquired through a sub-psychological process. This seems problematic. Regardless of our own sympathy for Fodor and Pylyshyn's position on the insufficiency of non-classical, neural network architectures as models of human cognition, if neural networks in the human brain were to enable flexible acquisition of novel concepts via something like Lockean abstraction, we think that the empiricist would be right to consider this a win.

We here focus on a second complication. In highlighting a variety of theoretical options available to concept nativists, the book serves as a useful handbook for understanding and situating a range of specific nativist proposals. Nevertheless, L&M do purport to offer an evaluable nativist proposal of their own which, simply stated, is that "*many* concepts across *many* different conceptual domains are either innate or acquired via rationalist learning mechanisms" (6) provided for in the acquisition base. This position is, furthermore, distinguished from "empiricist views" which "substantially underestimate the richness of the acquisition base underpinning human development" along with "many rationalist views… as well" (ibid.).

To properly evaluate L&M's proposal in comparison with these others, however, we require greater specificity about *which* concepts in *which* domains meet their conditions for concept nativism and how. L&M do explicitly distance their proposal from Fodor's brand of concept nativism, on which *all* lexical concepts, whether primitive (Fodor 1975;

1981) or complex (Fodor 2008), are innate (see Part IV of their book). But to assess whether they are right to nevertheless conclude that other rationalist proposals "substantially underestimate the richness of the acquisition base", much turns on the specific respects in which these conceptual domains are said to be innately structured. For instance, L&M intend to endorse a more expansive brand of concept nativism than that advocated by proponents of the core cognition hypothesis, according to which humans are endowed with a small number of special purpose systems for objects, places, forms, numbers, agents, and language (Spelke 2022). Yet, pending a clear specification of the innate mechanisms and representations involved in the acquisition of any given concept, it will remain unclear exactly how that hypothesis should be seen to have underestimated what is found in the acquisition base. In principle, it may be that the acquisition of comparative concepts like MORE and MOST (see e.g. Knowlton et al. 2021) is innately tied to the operations of some of these core systems, but that acquisition need not itself demand positing yet further core systems (we return to this point in Section 3).

To reiterate, this under-specification does not detract from the book's value as a welcome guide to nativist-friendly argumentation. However, it does render the book's final verdict somewhat unsatisfying, insofar as it sidesteps what many ultimately care about in debates between concept nativists and empiricists: which concepts and structures are innate, and in virtue of what.

In the following, we work out different ways of elaborating L&M's account to make that contribution in a domain which is considered throughout their book: number concepts. We will find that L&M vacillate between two "brands" of concept nativism in this domain but neglect to consider a third. Considering what flows from each such brand of nativist account, we suggest that L&M would do well to adopt the third. We close by considering certain ramifications for the acquisition of quantificational concepts more broadly.

2. Three brands of number nativism

a. Type A Number Nativism

The acquisition of number concepts is an important case study for the nativist. Numerical cognition is one of the best studied domains of pre-linguistic thought (Dehaene 2011), and many of our best-developed theories of concept learning have been formulated with respect to the acquisition of exact number concepts (Carey 2009). It is unsurprising, then, that this is one domain in which L&M are most emphatic that concept nativism obtains.

Echoing the above, their basic contention is that this is so, irrespective of whether specific number concepts like SEVEN are learned. For brevity, we shall call this view—that nativism obtains in the domain of number, even if the specific concepts are learned by means of appropriate nativist-friendly learning mechanisms—Type A Nativism.

To motivate Type A Nativism, L&M posit a role for the approximate number system (ANS) in number concept acquisition (see also: Margolis & Laurence forthcoming). The ANS is a psychological system that represents numbers per se (Clarke & Beck 2021; Beck & Clarke forthcoming) or numerical quantities of some more general variety (Samuels & Snyder 2024). However, unlike the representations generated by an adult's mature counting capacity, the ANS represents in a characteristically imprecise, approximate manner. Success in discriminating two numerical quantities with the ANS conforms to Weber's Law, and is thus a function of ratio, rather than absolute difference: as the ratio gets closer to 1:1, discrimination gets harder. For instance, using the ANS, discriminating 10 from 8 is easier than discriminating 10 from 12, despite the absolute difference remaining constant in either case.

There is abundant evidence for an ANS of this sort. For instance, one study (Barth et al. 2005) presented 5-year-olds with a set of blue dots on a computer screen, following which an opaque block slid across the screen and blocked the dots from view. A second set of red dots then moved onto the screen, and children were asked a straightforward question: Are there more blue dots (behind the block) or red dots (on the screen)? Despite being too young to reliably count the dots, researchers observed that the children performed significantly above chance and with errors as predicted by Weber's Law. That is, the further the ratio from 1:1, the better the children performed: they were more accurate when the sets differed in number by a ratio of 4:7 than when they differed by 4:6, and better on ratios 4:6 than 4:5.

This result in and of itself is unsurprising in light of much previous work (e.g., Xu & Spelke 2000; Lipton & Spelke 2003). More striking is that Barth et al. observed the same effect when they tested children of the same age on a cross-modal version of the task. In this variation, one of the sets of visually-presented dots was replaced with a sequence of auditorily-presented tones, and children were asked if there were more dots in the visually-presented set or in the sequence of heard tones. Children's accuracy and error patterns were no different than when they had compared two visually-presented sets.

As L&M and others note, cross-modal results of this sort are important when considering claims about the existence of an ANS, because they directly eliminate the potential for non-numerical factors to serve as the basis of participants' discriminations.[1] Use of visually-presented sets alone may otherwise be criticized for inadvertently providing cues to the expected answer by means of non-numerical confounds like average diameter, cumulative surface area, spatial density, or convex hull (e.g., Leibovich et al. 2017). However, sequences of heard tones lack these properties, ruling out such deflationary interpretations. Likewise, the confounds that one might worry about in a uniformly auditory discrimination task (e.g. the pitch, loudness, or duration of heard tones) are either absent in visually presented collections or easily controlled for.

It is thus difficult to see how results like Barth et al.'s could be explained without positing a basic competence to represent and discriminate the approximate number of items (whether dots or tones) in perceived collections. Moreover, cross-modal discriminations of this sort have been observed in a wide array of non-human animals like rats (Meck & Church 1983) and monkeys (Jordan et al. 2008), which may suggest evolutionarily ancient origins (L&M Ch.10). They have also been observed in newborn human infants, under 3 days old (Izard et al. 2009), who haven't yet had a chance to learn much of anything (L&M Chs. 8-9). L&M thereby follow the lion's share of researchers working on this topic in thinking that the ANS exists and, in L&M's terms, is most plausibly thought of as an innate component of our acquisition base.

How does this relate to concept nativism? Recall that Type A nativism holds that number concept acquisition vindicates nativism even if specific number concepts are not innate, but rather learned by means of appropriate nativist-friendly learning mechanisms. When wearing their Type A Nativist hat, L&M state that the existence of an innate ANS does vindicate nativism in this sense, irrespective of whether ANS representations themselves

---

[1] While L&M rightly appeal to cross-modal studies as showing that non-numerical confounds can be eliminated in ANS studies, the evidence that they cite is sometimes questionable. For instance, Margolis and Laurence (forthcoming) appeal to Arrighi et al.'s (2014) finding that sensory adaptation to number transfers across modalities, wherein e.g. hearing a large number of tones yields a repulsive visual aftereffect such that a seen collection of dots subsequently appears less numerous. However: these results have failed to replicate (Yousif, Clarke, & Brannon 2024); they cannot be experienced in the way that other visual aftereffects can (even alleged aftereffects to number – see Burr & Ross 2008); and, they are now the subject of a multisite adversarial collaboration scrutinizing their veracity. What matters for present purposes, of course, is that there are many reliable cross-modal number discrimination studies which can be leveraged in support of an ANS with genuine number content.

are concepts. More generally, in Type A mode, L&M can grant that there are no innate number concepts in the acquisition base, so long as they are "acquired on the basis of an acquisition base that contains a highly articulated, complex, domain-specific learning mechanism that is directed to the numerical domain" (Margolis & Laurence forthcoming, p. 9). Throughout their book, L&M often claim that the ANS is implicated in some such learning mechanism, remarking, in fact, that this "is all but inevitable" (p. 256).

They provide two reasons for this claimed inevitability. First, the ANS' characteristic ratio sensitivity is observed not only when children or adults (Barth et al. 2003) discriminate numbers of perceived items as in the studies just described, but also when numerate adults are tasked with discriminating numerals (Dehaene 1997). Moyer and Landauer (1967), for instance, asked adults to identify which among successive pairs of Arabic numerals (between 1 and 9) represented a larger number. This was an easy task for their participants; however, their reaction times showed a marked distance effect, increasing as they judged numerals representing numbers with ratios closer to 1:1. Follow up work by Buckley and Gilman (1974) showed that these discriminations also displayed a size effect, such that reaction times were affected by the absolute size of the smaller quantity discriminated. Together, these distance and size effects imply conformity to Weber's Law at some level of representation. This has convinced many – L&M included – that the ANS plays an important role in mature and conceptually-mediated numerical thought of a sort we might employ in a math class.

L&M's second reason (p.256-7, fn. 21; see also Margolis & Laurence forthcoming) for thinking that the ANS "inevitably" structures number concept acquisition is that early variation in the acuity of one's ANS predicts mathematical competence. For instance, Halberda et al. (2008) found correlations between individual differences in 14-year-olds' numerical approximation abilities and their past scores on standardized math tests. L&M interpret these findings as providing convergent evidence that, even if number concepts are learned rather than innate, such results would not obtain unless the acquisition of number concepts was supported by the ANS, further vindicating Type A Number Nativism.

How convincing are these two reasons? We are not sure. Take L&M's suggestion that the ANS is implicated in the finding that reaction times conform to Weber's Law when identifying the larger or smaller of two Arabic numerals. This suggestion is potentially problematic in that conformity to Weber's Law – as indexed by effects on reaction times

– obtains whenever two perceived magnitudes are discriminated, as well as when humans attempt to identify the larger or smaller of any two conceptualized quantities, including relative positions in a sequence. For example, conformity to Weber's law is observed when participants judge the ordinal positions of letters in the alphabet (Hamilton and Sanford 1978) or which of two stimuli is *better* or *worse* (Holyoak and Walker 1976). Reaction times may, thus, show conformity to Weber's Law whenever judgments must be formed about the differences between *any* of two stimuli in an ordered sequence. As a result, observing this pattern with Arabic numeral discrimination can't obviously implicate the ANS (or even a more generalized perceptual magnitude system; Walsh 2003), let alone show that the ANS is inevitably involved in the acquisition of the number concepts denoted by the numerals.

Do studies identifying correlations between ANS acuity and mathematical competence fare better in this regard? The studies cited above do demonstrate specific correlations between the ANS and a developing mastery of mathematics. But, even bracketing concerns that the observed correlations are weak (Carey & Barner 2019), it is not immediately clear that the results pertain to the *acquisition* of number concepts as L&M presume. A live possibility is that (exact) number concepts are acquired independently of the ANS, either through innate pre-programming (Clarke 2025) or distinct learning mechanisms (Carey 2009); once acquired, number concepts can then be linked up with the ANS as an aid to reasoning about numerical quantities in different kinds of tasks. For example, a mature understanding of the question "What is four plus eight?" demands exact number concepts. Nevertheless, a child might use their ANS to quickly assess whether candidate answers to this question are in the ballpark of being correct.

There is more to be said on all these matters. For present purposes, we can simply say that L&M's claim that the ANS "inevitably" structures number concept learning – and thereby that Type A Nativism surely obtains, even if exact number concepts are learned – strikes us as premature.

b. Type B Number Nativism

Type A Nativism holds that number concepts can be innately structured in advance of experience, without being innately hardwired into the acquisition base. And although L&M are keen to emphasize that Type A Nativism will suffice to vindicate the rationalism they care about in the domain of number, they occasionally set out to defend a *prima facie* stronger claim: that the representations manipulated by an innate ANS themselves *constitute* number concepts. We shall call this Type B Nativism.

L&M offer both positive and negative arguments for Type B Nativism.

On the one hand, L&M seek to rebut arguments to the effect that ANS representations *could not* qualify as concepts. The most prominent of these is Beck's (2012) argument that ANS representations aren't concepts because they fail to satisfy the Generality Constraint (cf. Evans 1982). The Generality Constraint, taken as a necessary condition on a representation *R* being qualified a "concept", requires that *R*'s distribution in thought be free up to the limit of its syntactic type.[2] For instance, if one is in possession of representations JOHN, LOVES, and MARY, and one is capable of entertaining the thought JOHN LOVES MARY, by the Generality Constraint we should say that this thought is constructed out of concepts only if one is immediately guaranteed the ability to entertain the thought MARY LOVES JOHN, etc.

Beck argues that the ANS's conformity to Weber's Law prevents its representations from systematically recombining in these ways. Take Xu and Spelke's (2000) claim that 6-month-olds can use their ANS to perform numerical discriminations if and only if the numerical quantities involved differ by a ratio of at least 1:2. Now suppose that a six-month-old who uses their ANS to think 8<16 and 12<24 thereby tokens ANS representations of 8, 12, 16, and 24. Despite these accomplishments, the infant is nevertheless incapable of recombining those constituents to formulate thoughts like 12<16 or 16<24, according to Beck, since 12:16 and 16:24 are below their 1:2 capacity limitation. Similar points apply irrespective of the specific ratio at which ANS discriminations are said to become impossible, and irrespective of whether the ANS is seen to represent exact numbers, numerical ranges, or even ranges with a probability distribution attached. So, Beck concludes, ANS representations fail to systematically recombine as required by the Generality Constraint and thus fail to qualify as concepts.

We (alongside more recent incarnations of Beck [2023]) side with L&M in rejecting this conclusion. However, we do so for slightly different reasons. L&M suggest that Beck's argument fails to preclude ANS representations qualifying as concepts because it

[2] Evans (1982), in a footnote, and others in subsequent works, add a further semantic restriction so as to exclude "category mistakes" from among the class of well-formed thoughts; we take this further restriction to have been ably rebutted by Camp (2004).

conflates competence and performance: while 6-month-olds may be unable to discriminate 12 from 16 objects *observed*, this doesn't show that they lack the competence to formulate the thoughts 12<16 or 16<24. Thus, ANS representations *might* meet the Generality Constraint, for all that Beck has shown. To our minds, this response alone seems too weak, absent some plausible proposal for why and which performance factors would give rise to *these highly specific ratio thresholds* in the subjects at issue.

As we see it, there is a more fundamental problem with Beck's argument. That is, *there simply are no such ratio thresholds* as needed to bolster the argument; Beck, in fact, erroneously assumes what Clarke (2023) has called "The Cliff Edge Model" of Weber's Law. According to that model, conformity to Weber's Law implies that there is a set ratio at which ANS discrimination suddenly becomes impossible. In tacit agreement with this model, L&M follow countless others in describing the ANS's thresholds for discrimination as 1:3 in newborns (Izard et al. 2009) and 1:2 in six-month-olds (Xu & Spelke 2000), etc. But this isn't the right way to think about Weber's Law (Halberda 2016).

For a start, the Cliff Edge Model conflicts with foundational work in psychophysics. Signal detection theory treats the discriminability of two collections as a continuous function of their ratio – as such, discrimination simply becomes more error prone as ratios approximate 1:1. Crucially, however, performance never truly falls to chance, as should be evident whenever the number of observations increases sufficiently. In a stunning vindication of this conjecture, Sanford & Halberda (2023) observed that people always performed significantly above chance in their ANS-based numerical discriminations, even with extremely difficult ratios, like 50:51 (the hardest ratio tested). Moreover, participants' errors were accurately modelled by the continuous functions predicted by signal detection theory, while poorly modelled by a rival Cliff-Edge Model. So, if we run enough trials, it seems that the ANS is nevertheless above-chance at identifying the larger numerical quantity. An ANS that can represent 4<50 and 5<51 would appear to be afforded the potential to represent 50<51. Indeed, an ANS that can represent 4<500 and 5<501 would appear to be afforded the potential to represent 500<501. And so on.

This casts doubt on Beck's argument – specifically, the premise that we *require* a specific ratio difference to perform ANS-based discriminations appears to be false. Supposing that there are hard-and-fast ratio limitations on the numerical representations that can be meaningly combined by the ANS is premised on a review of studies with an arbitrary number of trials; but, statistically above chance performance seems to always emerge with harder ratios if an appropriate number of trials are run. The upshot is that any time an organism can use their ANS to represent A<C and B<D, we should believe that they can use that system to represent A<B, irrespective of how close A:B is to 1:1.

These considerations clear space for the Type B Nativist view that ANS representations might indeed be number concepts. Yet, despite taking the time to defend this conclusion, L&M ultimately disregard it: their considered view is not so much that ANS representations do or don't conform to the Generality Constraint, but that the constraint itself cannot be relied upon to draw the conceptual/non-conceptual distinction. In defending Type B Nativism, L&M instead recommend a simpler cut:

> "a better way of approaching the question of whether approximate numerical representations are conceptual in animals (and by extension, in humans) is to ask whether such representations figure in a variety of higher cognitive processes such as categorization, planning, and decision making." (307)

Evading vexed issues regarding the proper mark of the conceptual, the proposal is that we can simply ask whether ANS representations play a role in the abovementioned characteristic cognitive processes. Proceeding to note that the ANS does play such roles, Type B Nativism is seen as inescapable.

For us, this way of categorizing ANS representations as concepts cheapens the issue. We do not deny that the ANS serves to facilitate *categorization, planning*, and *decision making*. In fact, the ANS as a posit has come to be widely accepted precisely because it has been observed to play such roles. For instance, when fish are deciding between which of two shoals to join, they tend to join the shoal with a larger number of fish (Hager et al. 1991; Buckingham et al. 2007), suggesting an operational ANS in these creatures (Messina et al. 2021). That is, we need something very much like an ANS to make sense of the fact that these creatures can *categorize* shoals in their environment based on their approximate number and use these categorizations to *decide* and *plan* which to join.

For sure, complications abound when philosophers attempt to clarify the distinction between conceptual and non-conceptual representations. Nevertheless, when researchers discuss number concepts and their origins, they are ultimately concerned with asking how we acquire the *exact* number representations we come to employ in the classroom, as when we think SEVENTEEN IS PRIME. For instance, Carey (2009) takes the hardline view that ANS representations play no role in the acquisition of these concepts, holding instead that they must be learned in culture-specific ways which tax entirely independent cognitive mechanisms devoid of any numerical content whatsoever.[3] Yet, neither Carey nor anyone else seriously engaging with ANS research would deny that ANS representations are conceptual *in L&M's deflated sense*. L&M are, of course, free to characterize concepts how they like. However, their Type B Nativism seems orthogonal to the concerns of those most invested in understanding numerical development.

A Type B Nativist might then do better by, instead, operationalizing a theory-light conceptual/non-conceptual distinction and asking if ANS representations are identical to the exact number concepts that children later employ in a maths class. But, substantive though it would be for a Type B Nativism to answer this question affirmatively, we think it implausible. One issue is that an identity between ANS representations and exact number concepts cannot accommodate the fact that the mapping between the outputs of our ANS and our considered judgments about how many items are in a set is unstable. A distinction between the two is required to make sense of the fact that one and the same ANS representation can give rise to the considered judgement that, in one context, a collection contains 20 items, and that, in another, it contains 40 (Sullivan & Barner 2013).

Hence, while Type B Nativism seeks to identify ANS representations and number concepts, the view is trivial if formulated as L&M recommend, and implausible if reformulated to engage with research in numerical and conceptual development.

c. Type C Number Nativism

L&M vacillate between Types A and B Nativism throughout the book when discussing the ANS and its relation to exact number concepts. But these two possibilities do not exhaust the options. Exact number concepts of the sort deployed in a math class could be learned on the basis of mechanisms that are entirely orthogonal to the ANS (e.g., Carey & Barner 2019). Or, more dramatically, they could be innate constituents of the acquisition base (Clarke 2025). We call this latter possibility Type C Nativism.

In some ways, it is strange that L&M do not emphasize Type C Nativism, since they have elsewhere recommended that a separate *small number system* (SNS) affords humans and other creatures with innate concepts of ONE, TWO, and THREE (Margolis 2021; c.f. Feigenson et al. 2004). That proposal leaves open, of course, how larger numbers come to

---

[3] Carey thus rejects Type A Nativism with respect to the ANS viz-a-viz mature number concepts.

be conceptualized – e.g., TWENTY-THREE or SEVENTY-TWO. However, Type C Nativism can naturally extend beyond the starting idea that SNS representations feature in an account of how larger number concepts are acquired, by proposing that the acquisition base contains the (finite) resources to generate the (infinite) sequence of natural numbers (Leslie et al. 2008). For instance, the acquisition base may contain ONE, TWO, and THREE, plus the pre-requisites for generating larger numbers from them in conformity with the successor function. On this view, one can maintain that all natural number concepts are innate, even for those so large that one has not had occasion to think of them directly. What it is to possess the concept of any such number is already provided for in the acquisition base.

L&M do not discuss such a view in their book. However, in a recent chapter of a forthcoming volume they mention a recent defence of it (Clarke 2025), only to claim that it relies on an "overly narrow view of concept nativism" (Margolis & Laurence forthcoming). Now, to some extent "concept nativism" is a term of art, and L&M can use it however they want. But regardless of whether Type C Nativism is a narrower thesis than number nativism as L&M understand it, the view should be considered on its own merits, not least because it enjoys several virtues over the proposals that L&M seem more enthusiastic about.

Consider that, unlike L&M's Type B Nativism, Type C Nativism directly engages with the concerns of developmentalists who are interested in how exact number concepts are acquired (Carey 2009; Spelke 2017). And while Type C Nativism is not popular, it is ironic that L&M have in fact done much to show that standard arguments against it are unpersuasive. For example, where rival accounts maintain that exact number concepts must be learned given the unusually protracted developmental trajectory involved in acquiring an understanding of number words (Le Corre & Carey 2007), Margolis (2021) notes that there may be special reasons why children have difficulty accurately mapping pre-existing number concepts onto number words (see also: Spelke 2017; Clarke 2025). Likewise, Laurence and Margolis (2007) have rightly noted that there are problems with cross-cultural evidence widely interpreted as showing that acquiring exact number concepts depends on culturally inherited number words (see also: Butterworth 2008; Clarke 2025). Such considerations clear space for Type C Nativism to be taken seriously.

Of course, these considerations don't show that Type C Nativism is true. However, a further consideration is that recent empirical studies have borne out some of its distinctive predictions.

To appreciate this, consider that accounts on which number concepts are learned, rather than innate, are often motivated by the lack of evidence that infants and young children can represent exact numbers outside of the "subitizing" range (Spelke 2017). For instance, it may appear that infants' only performative facility with numbers >3 is approximate, making use of their ANS. Yet, recent findings suggest that children, even young infants, do perform large and exact number discriminations under certain conditions.

In the domain of grammar learning, for example, sophisticated computational models make sharp predictions about the frequency with which a grammatical rule must be respected in order for it to be productively generalized to new cases. Charles Yang's (2018) influential work on the Tolerance Principle holds that a given grammatical rule will be productively generalized to novel cases just in case the number of observed exceptions to the rule does not exceed the total number of observed types falling under the rule, divided by the natural logarithm of that total. This amounts to the prediction that, in a grammatical domain with 10 types, at least 6 (60%) of these must conform to the relevant rule for that rule to be productively generalized. In a domain with 20 types, at least 14 (70%) of these must conform. More generally, the relative number of exceptions that can be tolerated decreases with domain size and must therefore be calculated from that domain's size on a case-by-case basis.

The predictions of Yang's Tolerance Principle have now been borne out with astonishing accuracy. To give just one example, Shi and Emond (2023) exposed non-Russian-speaking 14-month-olds to 16 three-word sentences of Russian, which either conformed or failed to conform to a certain movement rule (ABC → BAC vs. ABC → ACB). Given a domain with 16 types, the Tolerance Principle predicts that productive generalization should occur only if there are <5.77 exceptions. If 11 sentences conformed to the movement rule and 5 did not, the Tolerance Principle thereby predicts that generalization would occur. Consistent with this prediction, a first experiment showed that infants looked significantly longer when a subsequent test stimulus failed to follow the rule that was otherwise respected by 11 sentences in their exposure set. By contrast, a second experiment testing different infants provided an identical training set except only 10 of the sentences conformed to the rule, leaving 6 exceptions – a number that now exceeded the predicted tolerance threshold. In this case, infants did not look significantly longer when the subsequent test item failed to conform to the rule. 14 month-olds appear to have thereby distinguished sets containing 11 regulars and 5 exceptions from sets containing 10 regulars and 6 exceptions, given a common set size of 16, in perfect harmony with the predictions of Yang's Tolerance Principle. To put this result into context, note that if children had misrepresented these collections as containing even 17 types, the Tolerance Principle would now predict that the infants should tolerate the 6 exceptions.

It is not hard to find other studies that similarly vindicate the exact predictions of Yang's Tolerance Principle (Schuler et al. 2016; Yang 2016; see also: Gomez & Lakusta 2004; Koulaguina & Shi 2013; 2019). Yet these data run counter to the predictions of mainstream accounts of number cognition according to which representations of exact natural number must be learned. The competence to discriminate 5 sentence types from 6 should be way beyond the threshold at which ANS-based discrimination is possible for just about anyone, but certainly for 14 month-olds. This is because Shi and Emond's infants' ability to discern 5 or 6 rule-violating sentence types, and appreciate the significance of this difference given a collection of 16 (not 17) sentence types, emerged in a study comprising a comparable number of trials to studies of ANS acuity run in infants, like Xu and Spelke's (2000), and despite these infants being tested on considerably less trials than adults when found to perform an apparent maximum of 7:8 discriminations (Barth et al. 2003). So, while it is true that adults can be shown to perform harder discriminations using their ANS (e.g., 50:51) when evaluated over *hundreds of trials* (Sanford & Halberda 2023), the 14 month-olds who were tested by Shi and Emond discriminated between numerical subsets of 5 versus 6, within larger collections of 16, with a level of precision that is unheard of in ANS tasks, even tasks run on adults, despite the well-established observation that ANS acuity improves during development (Libertus & Brannon 2010; Clarke et al. 2025). This strongly suggests that some orthogonal system of exact enumeration was being employed by the infants in Shi and Emond's study.

Of course, it remains an open question whether the numerical representations underwriting infants' success in such studies form the basis of our mature and exact number concepts. However, a third and independent reason to seriously explore Type C Number Nativism is that it avoids a dilemma faced by rival accounts (Clarke MS).

Suppose for the dilemma's construction that mainstream accounts of numerical development are correct in maintaining that children must learn to represent natural numbers and that, prior to accomplishing this, their only facility with large numbers is via the imprecise representations produced by the ANS (Carey & Barner 2019). Suppose, further, that these ANS representations differ from the mature number concepts by (e.g.) "obscuring the successor function" (Carey 2009: 295) or other structural properties of the exact concepts that must ultimately be learned.

The first horn of the dilemma is that, if this is correct, then it is difficult to see why children would not form deviant mappings between their number representations and corresponding labels in natural language. Why, on such a view, would the representations at children's disposal not lead them to behave as if words for larger numbers are less differentiated, corresponding to the approximate numerical values at their disposal? This is troubling, since the evidence which motivates learning accounts suggests that children never do this: in learning the meanings of number words, children move through crisp successive stages in which they become *one knowers,* then *two knowers*, etc. such that they correctly respond to requests for *one* or *two* items respectively, but continue to give a *random* number of items when asked for any larger quantity.

The second horn of the dilemma looms if one, instead, denies that the ANS obscures the successor function or holds that there are additional mechanisms in the acquisition base which dictate that number concepts conform to the successor function and the other properties that distinguish a mature grasp of natural number. For, at this point, there appears little daylight left between the resulting view and the Type C Number Nativism that L&M and others seem to avoid: both would agree that the acquisition base contains the finite resources needed to generate large and exact number representations.

One is left wondering whether L&M are so keen to show how accommodating nativists can be, that they have neglected to acknowledge that a straightforward and well-motivated brand of number nativism is being swept under the rug.

3. Broader Ramifications

To close our discussion, we underscore that L&M should care about these distinctions, and about the question of which numerical representations, specifically, are in the acquisition base, as this can help us to appreciate when and how rationalist friendly mechanisms might structure rationalist learning more generally – the idea that L&M care most to motivate. For instance, we have seen that the exact numerical representations required by the Tolerance Principle help to structure grammar learning, and there may be reason think that ANS representations of rational numbers (Clarke & Beck 2021; Qu et al. 2024) guide children in their learning more generally, enabling them to focus their attention on statistically surprising events from which there is more to learn (Xu 2019). In fact, while we may have seemed unenthusiastic in our presentation about the role that ANS representations play in numeric conception, we expect that such representations (and approximate magnitude representations more generally) play important domain-specific roles in the acquisition of other concepts.

Consider, for instance, comparative words like *more* and *most*. Although semantic theory had long modeled the meaning of *most* in terms of precise cardinalities, Halberda, Taing, and Lidz (2008) found an important dissociation between children's early knowledge of exact number words and their understanding of *most*. After assessing knowledge of exact number words using the Give a Number and How Many tasks, Halberda et al. presented children with pictures of two sets of animals and asked them which contained "most". They observed that some of the children who had not yet grasped the meaning of exact number words ("non-counters") performed above chance on the Most task, and that some of those who had ("full counters") performed at chance. This suggests that a facility with exact number words is neither necessary nor sufficient for children's initial comprehension of *most*. Examining these groups more closely, the researchers found that the non-counters' pattern of errors was consistent with the ratio-dependent signature of the ANS, and suggestive evidence that this signature was evinced in the full-counters' performance as well: their data displayed a slight trend of ratio-dependent performance. However, Halberda et al did not examine individual children's data to see whether the slight trend obscured further differences within the full counters; subsequent work has explicitly tested and confirmed this, however (Odic et al. unpublished), suggesting that exact number word and *most* acquisition are independent.

Without longitudinal data, we cannot conclude too much about the developmental trajectory of knowledge of quantifier semantics viz a viz exact number concepts and approximate number. However, it is reasonable to suppose that the meaning of *most*, like its closely related counterpart, *more*, is initially connected with systems responsible for representing magnitudes, quite generally, albeit approximately. For one thing, neither *most* nor *more* is unambiguously specified for NUMBER; in full generality, they quantify and compare any magnitudes that people are capable of representing (e.g., *most of the soup*, *more beautiful, the most expensive*; Wellwood, 2019, 2020). Nevertheless, both non-counters (Halberda et al. 2008) and fully numerate adults under time pressure use their ANS to evaluate *most* and *more* sentences (Pietroski et al. 2009, Knowlton et al. 2021), discouraging the thought that numerate adults' use of exact natural number in assessments of *most* are fundamentally different in kind. Plausibly, then, children initially acquire *most* and *more* (at least when applied to count nouns like *ducks*) in terms that make verification via the ANS directly and readily appropriate. Adults retain that knowledge but know something more – that exact counting can be a *better* verification procedure for that meaning (see Hunter & Wellwood 2023 for a formal treatment).

On the face of it, this pattern of results might seem congenial to an empiricist, who maintains that the meaning of e.g. *most* (and MOST) is learnt from experience. After all, that position might neatly accommodate the protracted development, outlined above, where *most* is first mapped to approximate magnitudes and only later to exact number concepts. In fact, an empiricist might be emboldened to note that children need to learn the ordering relations specified when mapping *most* to approximate magnitude representations, as reflected in the fact that certain non-counters understand *most* as meaning *least* (Halberda et al 2008, Odic, Pietroski, et al 2013; Odic et al, unpublished).

On inspection, however, we think that an empiricist account of comparative concepts like this is unlikely. For one thing, children make very fine-grained distinctions in their use of these expressions. For instance, by age 3 years 3 months, children demonstrate adult-like understanding of *more goo* in terms of area and *more dots* in terms of number, even when these dimensions are manipulated orthogonally (Odic et al 2013). And, plausibly by age 4 at least, children perform subset-superset comparisons between two sets of dots given *most* but subset-subset comparisons given *more* (Knowlton et al 2021. Since the latter result holds in circumstances where these differences in cognitive operation fail to support differences in truth value, it is hard to see how or why these diverging "cognitive instructions" could be taught or otherwise learnt from experience. It is, thus, plausible to conjecture that an initial mapping between comparative concepts, like MOST, and innate systems of approximate magnitude representation is innately structured in advance of experience.

We further conjecture that children's subsequent mapping of these concepts onto exact number concepts is likewise pre-structured. On the above picture, children first map *more/most* to approximate magnitude concepts, with *more* meaning something like LARGER-APPROXIMATE-CARDINALITY – a genuinely distinct relation from that involving exact number comparison. The empiricist will maintain that children enter into a process of conceptual change, induced by counting practice. Following that conceptual change, the child comes to understand that *more*, polysemously, can also mean LARGER-EXACT CARDINALITY. But how would children come to appreciate and posit this new meaning?

Replacing one conceptual scheme with another, presumably, requires that the child recognize the inadequacy of their current concepts. Yet it is unclear how or why they would do this in the case at hand. To illustrate the problem, first note that ANS representation would enable children to accurately and reliably identify MORE and MOST in many contexts, at least when the collections differ in size by a suitably large ratio. For instance, upon presenting children with two collections, they might correctly recognize that, e.g., "This array has THREEISH chickens, and that array has FIVEISH cows" and proceed to conclude "Since FIVEISH > THREEISH, there are *more* cows." In such situations, there is nothing deficient about their ANS-based procedure. But even in cases where the ratios sit closer to 1:1, rendering children liable to make mistakes when using ANS representations to formulate MORE thoughts, correction via an exact counting procedure will always be compatible with mapping such conclusions onto approximate numerical values. Ditto with tracking the testimony of adults: every true verifiable instance of "three chickens" will have corresponding ANS-based interpretations such as "THREEISH chickens". In other words, if one is willing to think that what is one chicken in the world is ONEISH chickens – if a child understands exact number words that way early on – nothing in one's experience alone should compel one to think that this is wrong.

Type C Number Nativism, of the sort defended above, soothes this problem. Under Type C Nativism, the innate acquisition base contains tacit knowledge that numbers are positions in a structure defined by the successor function which, by construction, defines an exact number comparison relation. This knowledge is implicit, evidenced in work like that on the Tolerance Principle, showing that 14 month-olds distinguish small differences in the numbers of sentence types within a domain (Shi and Emonds 2023). But, if distinct systems of ANS based representation and exact number concepts represent the same thing – albeit with differing levels of precision – and children tacitly know this, then we can begin to see how the integration of ANS and exact number concepts might emerge when counting experience, speed, and (plausibly) experience with situations where the ANS errs but counting succeeds. Either way, such speculations illustrate that clarity on the specific contents of the acquisition base is likely to prove invaluable when assessing the space of options open to the concept nativist, as L&M conceive of those options.

References:

- Arrighi, R., Togoli, I., & Burr, D. C. (2014). A generalized sense of number. *Proceedings. Biological sciences*, *281*(1797), 20141791.
- Barth, H., Kanwisher, N., & Spelke, E. (2003). The construction of large number representations in adults. *Cognition*, *86*(3), 201–221.
- Barth, H., La Mont, K., Lipton, J., & Spelke, E. S. (2005). Abstract number and arithmetic in preschool children. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(39), 14116–14121.
- Beck, J. (2012). The Generality Constraint and the Structure of Thought. *Mind*, 121 (483), 563–600
- Beck, J. (2023). Contents and Vehicles in Analog Perception. *Crítica: Revista Hispanoamericana de Filosofía* 55 (163):109–127.
- Beck, J. & Clarke, S. (forthcoming). Cardinality, numerousness, and autoscaling: Revisiting the content and format of the approximate number system. In J. Park et al. (Eds.) *Numerical Cognition: Debates and Disputes.*
- Buckingham, J. N., Wong, B. B. M., & Rosenthal, G. G. (2007). Shoaling decisions in female swordtails: How do fish gauge group size? *Behaviour, 144*(11), 1333–1346.
- Buckley, P. B., & Gillman, C. B. (1974). Comparisons of digits and dot patterns. *Journal of Experimental Psychology, 103*(6), 1131–1136.
- Buckner, C. (2018). Empiricism without magic: transformational abstraction in deep convolutional neural networks. *Synthese* **195**, 5339–5372.
- Burr, D., & Ross, J. (2008). A visual sense of number. *Current biology, 18*(6), 425–428.
- Butterworth, B., Reeve, R., Reynolds, F., & Lloyd, D. (2008). Numerical thought with and without words: Evidence from indigenous Australian children. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(35), 13179–13184.
- Camp, E. (2004), The Generality Constraint and Categorial Restrictions. *The Philosophical Quarterly*, 54: 209-231.
- Carey, S. (2009). *The Origin of Concepts.* Oxford, Oxford University Press.
- Carey, S., & Barner, D. (2019). Ontogenetic Origins of Human Integer Representations. *Trends in cognitive sciences*, *23*(10), 823–835.
- Clarke, S. (2023). Compositionality and constituent structure in the analogue mind. *Philosophical Perspectives*, 37: 90–118.
- Clarke, S. (2025). Number nativism. *Philosophy and Phenomenological Research*, 110, 226–252.
- Clarke, S. (MS). Mad Dog Nativism, Neural Networks, and The New Riddle of Concept Learning.
- Clarke, S., & Beck, J. (2021). The number sense represents (rational) numbers. *Behavioral and Brain Sciences, 44,* Article e178.
- Clarke, S., Qu, C., Luzzi, F. and Brannon, E. (2025), Children's Number Judgments Are Influenced by Connectedness. *Developmental Science*, 28: e70032.

- Dehaene, S. (1997). *The Number Sense: How the Mind Creates Mathematics.* Oxford, Oxford University Press.
- Evans, G. (1982). The Varieties of Reference. Oxford, Oxford University Press.
- Feigenson, L., Dehaene, S., & Spelke, E. (2004). Core systems of number. Trends in cognitive sciences, 8(7), 307–314.
- Fodor, J. A. (1974). Special Sciences (Or: The Disunity of Science as a Working Hypothesis). Synthese, 28(2), 97–115.
- Fodor, J. (1975) *The Language of Thought*, New York: Thomas Y. Crowell.
- Fodor, J. (1981) *Representations,* Cambridge, MA: MIT Press.Fodor 1975
- Fodor, J. (2008). *LOT 2: The Language of Thought Revisited.* Oxford: Oxford University Press.
- Fodor, J. A., & Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. *Cognition*, 28(1-2), 3–71.
- Gómez, R. L., & Lakusta, L. (2004). A first step in form-based category abstraction by 12-month-old infants. *Developmental Science, 7*(5), 567–580.
- Hager, M. C., & Helfman, G. S. (1991). Safety in numbers: Shoal size choice by minnows under predatory threat. *Behavioral Ecology and Sociobiology, 29*(4), 271–276.
- Halberda, J. (2016). Epistemic limitations and precise estimates in analog magnitude representation. In D. Barner & A. S. Baron (Eds.), *Core knowledge and conceptual change* (pp. 171–190). Oxford University Press.
- Halberda, J., Mazzocco, M. M., & Feigenson, L. (2008). Individual differences in non-verbal number acuity correlate with maths achievement. *Nature*, *455*(7213), 665–668.
- Halberda, J., Taing, L., & Lidz, J. (2008). The Development of "Most" Comprehension and Its Potential Dependence on Counting Ability in Preschoolers. Language Learning and Development, 4(2), 99–121.
- Hamilton, J. M., & Sanford, A. J. (1978). The symbolic distance effect for alphabetic order judgements: A subjective report and reaction time analysis. *The Quarterly Journal of Experimental Psychology, 30*(1), 33–41.
- Holyoak, K. J., & Walker, J. H. (1976). Subjective magnitude information in semantic orderings. *Journal of Verbal Learning & Verbal Behavior, 15*(3), 287–299.
- Hunter, T., & Wellwood, A. C. (2023). Linguistic meanings interpreted. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 45.
- Izard, V., Sann, C., Spelke, E. S., & Streri, A. (2009). Newborn infants perceive abstract numbers. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(25), 10382–10385.
- Jordan, K. E., Maclean, E. L., & Brannon, E. M. (2008). Monkeys match and tally quantities across senses. *Cognition*, *108*(3), 617–625.
- Knowlton, T., Hunter, T., Odic, D., Wellwood, A., Halberda, J., Pietroski, P. and Lidz, J. (2021), Linguistic meanings as cognitive instructions. *Annals of the New York Academy of Sciences*, 1500: 134-144.
- Koulaguina, E., & Shi, R. (2013). Abstract rule learning in 11- and 14-month-old infants. *Journal of psycholinguistic research*, *42*(1), 71–80.
- Koulaguina, E., & Shi, R. (2019). Rule Generalization from Inconsistent Input in Early Infancy. *Language Acquisition*, *26*(4), 416–435.

- Leibovich, T., Katzin, N., Harel, M., & Henik, A. (2017). From "sense of number" to "sense of magnitude": The role of continuous magnitudes in numerical cognition. *The Behavioral and brain sciences*, *40*, e164.
- Libertus, M. E., & Brannon, E. M. (2010). Stable individual differences in number discrimination in infancy. *Developmental science*, *13*(6), 900–906.
- Lipton, J. S., & Spelke, E. S. (2003). Origins of number sense. Large-number discrimination in human infants. *Psychological science*, *14*(5), 396–401.
- Laurence, S., Margolis, E. (2007). Linguistic Determinism and the Innate Basis of Number. In P. Carruthers et al. (eds.), *The Innate Mind, vol. 3: Foundations and the Future* (Oxford University Press), pp. 139-169.
- Le Corre, M., & Carey, S. (2007). One, two, three, four, nothing more: an investigation of the conceptual sources of the verbal counting principles. *Cognition*, *105*(2), 395–438.
- Margolis, E. (2020). The Small Number System. *Philosophy of Science*, *87*(1), 113–134.
- Margolis, E., & Laurence, S. (forthcoming). Why the Number System Supports Concept Nativism—Even if There Are No Innate Concepts. In J. Park et al. (eds). *Numerical Cognition: Debates and Disputes* (Springer Nature).
- Meck, W. H., & Church, R. M. (1983). A mode control model of counting and timing processes. *Journal of Experimental Psychology: Animal Behavior Processes, 9*(3), 320–334.
- Messina, A., Potrich, D., Schiona, I., Sovrano, V. A., & Vallortigara, G. (2021). The Sense of Number in Fish, with Particular Reference to Its Neurobiological Bases. *Animals : an open access journal from MDPI*, *11*(11), 3072.
- Moyer, R. S., & Landauer, T. K. (1967). Time required for judgements of numerical inequality. *Nature, 215*(5109), 1519–1520.
- Nasr, K., Viswanathan, P., & Nieder, A. (2019). Number detectors spontaneously emerge in a deep neural network designed for visual object recognition. *Science Advances,* 5(5) 7903.
- Odic, D., Pietroski, P., Hunter, T., Lidz, J., & Halberda, J. (2013). Young children's understanding of "more" and discrimination of number and surface area. *Journal of experimental psychology. Learning, memory, and cognition*, *39*(2), 451–461.
- Odic et al. unpublished
- Pietroski, P., Lidz, J., Hunter, T. and Halberda, J. (2009), The Meaning of 'Most': Semantics, Numerosity and Psychology. *Mind & Language*, 24: 554-585.
- Qu, C., Clarke, S., Luzzi, F., & Brannon, E. (2024). Rational number representation by the approximate number system. *Cognition*, *250*, 105839.
- Samuels, R. (2002), Nativism in Cognitive Science. Mind & Language, 17: 233-265.
- Samuels R. (2004). Innateness in cognitive science. *Trends in cognitive sciences*, *8*(3), 136–141.
- Samuels, S. & Snyder, E. (2024). *Number Concepts: An interdisciplinary inquiry.* Cambridge University Press.
- Sanford, E. M., & Halberda, J. (2023). Successful Discrimination of Tiny Numerical Differences. *Journal of Numerical Cognition*, *9*(1), Article e10699.
- Schuler, K. D, Yang, C., & Newport, E. L. (2016). Testing the Tolerance Principle: Children form productive rules when it is morecomputationally efficient to do so. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 38.

- Shi, R., & Emond, E. (2023). The threshold of rule productivity in infants. *Frontiers in Psychology,* 14, 1251124.
- Spelke, E. S. (2017). Core knowledge, language, and number. *Language Learning and Development, 13*(2), 147–170.
- Spelke, S. (2022). *What do babies know?* Oxford: Oxford University Press.
- Sullivan, J., & Barner, D. (2013). How are number words mapped to approximate magnitudes? *The Quarterly Journal of Experimental Psychology, 66*(2), 389–402.
- Walsh V. (2003). A theory of magnitude: common cortical metrics of time, space and quantity. *Trends in cognitive sciences*, *7*(11), 483–488.
- Wellwood, A. (2019). *The meaning of more.* Oxford: Oxford University Press.
- Wellwood, A. (2020). Interpreting degree semantics. *Frontiers in Psychology,* 10.
- Xu F. (2019). Towards a rational constructivist theory of cognitive development. *Psychological review*, *126*(6), 841–864.
- Xu, F., & Spelke, E. S. (2000). Large number discrimination in 6-month-old infants. *Cognition*, *74*(1), B1–B11.
- Yang, C. (2018) *The Price of Linguistic Productivity,* MIT Press.
- Yang, C. (2016). The linguistic basis of next number. *LingBuzz.* Universitetet i Tromsoe.
- Yousif, S. R., Clarke, S., & Brannon, E. M. (2024). Number adaptation: A critical look. *Cognition*, *249*, 105813.