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Where the Sidewalk Ends: The Limits of Social Constructionism

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The sociology of knowledge is a heterogeneous set of theories which generally focuses on the social origins of meaning. Instead of meaning inhering in objects themselves or being imposed idiosyncratically by individuals, meaning is hypothesized to emerge out processes of social interaction- e.g., traditions, norms, practices, rituals, institutions, habits, etc. (Berger and Luckmann, 1966; Bloor, 1983, 1986; Bourdieu, 1977; Danziger, 1997; Durkheim, 1995; Mannheim, 1936; Rawls, 1996; Zerubavel, 1997). The social world is an independent, external reality to which the individual must adapt or face sanctions. This ensures a measure of cognitive conformity.

Despite a number of programmatic pieces from sociologists interested in the intersection of culture and cognition (Cerulo, 2002; DiMaggio, 1997; Martin, 2010; Zerubavel, 1997), the extent of this relationship remains unclear. Is it culture and cognition "all the way down" or is there some bedrock of cognition that is independent of cultural influence? If so, what limits does this place on cultural variability and what does this mean to the problems of incommensurability and relativity that have dogged the sociology of knowledge from its inception?

Theorists in the German tradition of the sociology of knowledge have largely avoided these questions. Concepts like "ideologies" (Mannheim, 1936) and "thought styles" (Fleck, 1935) have been used to explain differences in individual reasoning processes by appealing to aspects of social life like group interests or professional socialization. Social constructionism emerged from this tradition and provided tools for exploring the micro-processes that give rise to knowledge. For Berger and Luckmann (1966), concepts develop locally in order to harmonize interaction. Through repeated use, these "typifications" (Schutz, 1973) become habits. As they become further sedimented in interactional routines and concretized in institutions, they take on the appearance of objective reality and the origins of the concept are obscured.

Although this literature is quite diverse, Danziger (1997) finds two common themes; an emphasis on the discursive formation of knowledge and the demystification of scientific knowledge. The vast majority of work in this field has been concerned with demonstrating how apparently universal and unassailable categories or pieces of knowledge are produced in contingent and path-dependent ways (Hacking, 2000). Yet, this work has been overwhelmingly concerned with mature cultural categories like race, gender, and mental illness which clearly differ both historically and cross-culturally.

Do these same social constructionist arguments hold for more fundamental forms of cognition like object and agency perception, theories of causality, and arithmetic? The outcome of this question has serious implications for the relativity of knowledge and the prospects of science. If the very categories our minds use to understand reality are produced through local social interaction, than another location, with different interactional routines, might produce very different categories. While most research in the sociology of knowledge has avoided this question, there have been some compelling attempts to ground the most basic forms of thought in social interaction (Bloor, 1986; Durkheim, 1995; Durkheim and Mauss, 1967; Rawls, 1996; Wittgenstein, 1991). However, there has been an ongoing backlash against these views from social scientists who believe that biology and psychology make distinct and irreducible contributions to thought (Bergesen, 2004a, 2004b; Freese, 2008; Freese, Li, and Wade, 2003; Lizardo, 2007; Turner, 2007; Wrong, 1961).

Over the past 50 years, cognitive psychology has made many advances in understanding the origins of concepts. This work has, with some exceptions, been ignored in the sociological literature. Historically, the reason for ignoring psychology, according to Wrong (1961), has been a disciplinary reaction to the threat of reductionism. If concepts can be shown to be innate then the domain of the sociology of knowledge is greatly reduced. However, the evidence from cognitive science actually presents a far more complex picture of the development of the mind than crude concepts like "innate" or "biological" suggest. It is important to acknowledge that volumes of studies have clearly demonstrated that we are endowed with certain forms of innate intelligence. However, there is an important, but largely unrecognized, difference between innate intelligence and explicit knowledge which necessitates a reformulation of the sociology of knowledge.

This paper is divided into three parts. The first will introduce Durkheim's sociology of knowledge and a recent critique by Bergesen (2004a) which attacks it utilizing findings from developmental psychology. These studies show that many of the categories Durkheim attributed to the social order are operational in pre-socialized children. The second section looks at the developmental psychological and anthropological literature on number more closely in order to counter Bergesen's strong innateness claims. Specifically, I will suggest that the evidence from these disciplines reveals a fundamental difference between innate intelligence and explicit knowledge. Finally, I will offer some suggestions for a better, more grounded sociology of knowledge.

DURKHEIM AND THE CATEGORIES OF THOUGHT

In *The Elementary Forms of Religious Life* (1995), Emile Durkheim famously argued that neither empiricist nor rationalist theories of knowledge could account for the categories of thought. Derived from Aristotle, these categories include cognitively foundational concepts like time, space, number, cause, substance, and personality.[1] The problem, as Durkheim posed it, was that neither could account for both the perceived necessity and universality of the categories as well as their shifting definitions between cultures and over time.

Empiricism, he argued, is actually a veiled form of irrationalism since the categories that develop through associational mechanisms do not inhere in the objects themselves. If you think as you do because of your particular experiences, you may have developed differently given different experiences. With this theory, there can be no logical necessity, only probabilistic association.

On the other hand, rationalism attributes ordering categories to the human mind but does not offer any empirical support. More importantly, if these categories were truly our birthright, we would not expect the cultural differences that Durkheim argued were apparent (a claim we will explore later).

In opposition to these hoary philosophical positions, Durkheim offered a radical alternative:

> Logical life obviously presupposes that man knows, at least confusedly, that there is a truth distinct from sense appearances. But how could we have arrived at any such idea? [. . .] Solely because society exists, there also exists beyond sensations and images a whole system of representations that possess marvelous properties [. . .] They have a kind of force and moral authority by virtue of which they impose themselves upon individual minds. From then on, the individual realizes, at least dimly, that above his private representations there is a world of type-ideas according to which he has to regulate his own . . . (Durkheim, 1995: 437–438)

His solution, audaciously positing society as the soil from which the categories of thought spring, has helped give rise to the sociology of knowledge. While many varieties of the sociology of knowledge have since emerged, Durkheim's formulation remains resonant as its placement of society at the fount of all thought makes sociology, in effect, the queen of the sciences.

However, many sociological theorists have criticized Durkheim's epistemological argument for leading into a vicious circle (Coser, 1971: 140; Godlove, 1989: 40; Lukes, 1973: 447; Parsons, 1968: 447). How could society give rise to the most primitive structures of thought? Doesn't social life, in fact, presuppose and require these categories? Thus, Durkheim's epistemology has often been dismissed in favor of his more moderate arguments concerning differences in classificatory structures between cultures (Rawls, 1996: 462–68).

Rawls (1996) has mounted a defense of Durkheimian epistemology suggesting that, for Durkheim, specific classificatory structures are secondary phenomena that spring from the primary soil of social life, the enacted practices which give rise to conceptual categories. She does not deny all native intelligence. However, she argues that individuals are born with only crude cognitive abilities, no different from the primitive types of association and distinction witnessed in animals. These amount to little more the intelligence inherent in perception itself. But unlike animals, we are not limited to these crude abilities. Through participation in collective activities the individual learns universal categories that will only later be populated by specific ideas. For instance, Rawls claims that the individual's perception of collective moral expression gives rise to the category of "force."

However, Schmaus (1998) critiques Rawls' strategy of grounding the categories in perception, suggesting that she doesn't adequately address the classic argument made by Hume that universal categories can never be derived from specific experiences. The moral will of the group is only available as an empirical event from which we could never reach a universal concept. Instead he suggests that Durkheim's epistemology can be salvaged by recognizing the distinction between the categories of thought and their specific instantiation in specific cultural forms (Schmaus, 2004). The categories themselves are universal, innate, and constitute the necessary conditions of social life but their actual representation may differ between cultures. Thus, as Durkheim suggested, the categories are both universal *and* variable.

The theoretical arguments surrounding Durkheim's epistemology have greatly clarified the relationship between culture and cognition. However, a growing body of empirical evidence has provided a new and different challenge which must be addressed. Using evidence from developmental psychology, Bergesen (2004a) has made the case that all of the categories that Durkheim attributes to the influence of society are exhibited by pre-socialized infants. In a whirlwind tour of the literature, Bergesen cites studies demonstrating our innate knowledge of space, number, cause, substance, personality, and categories of objects. Summarizing these studies, he writes, "The specific mental categories Durkheim mentioned all seem to show signs of being operative in newborns and very young infants, who have not, everyone would agree, been socialized" (2004a: 407).

Nietzsche (1954: 470) once commented that we often make mistakes in pairs. One error leads us to overcompensate and make a second. I believe we find that dynamic here. Bergesen's critique is necessary and laudable. He brings empirical work from a fascinating and emerging discipline to bear on a theoretical argument which is often accepted uncritically. However, I will show that the nativist conclusion he arrives at is too broad and simplifies what is actually a complex relation with an important role for social factors.

The position that our minds are wholly social products is certainly untenable in light of theoretical and empirical research. But simply attributing the categories of thought to infants is an equal mistake. Theorists like Rawls and Schmaus have attempted to skate this line by either suggesting humans have some "crude" innate abilities (Rawls, 1996: 447) or by divorcing transcendent categories from specific cultural instantiations of those categories (Schmaus, 2004). While there is truth to both of these positions, the evidence now allows us to make far more specific arguments regarding the relationship of innate intelligence, cultural representation, and the categories of thought.

To do this, I will reexamine the research Bergesen uses to make his strong innateness argument. Due to the ambitious scope of Bergesen's argument, I cannot address all of the evidence he offers in support of his claims. I will address just the issue of number in depth. However, the origin of number and mathematics is a particularly important area for the sociology of knowledge to confront as it has been cited, at least since Descartes, as proof that there exists an ultimate ground of objective (e.g., non-constructed, non-social) truth. If there is a procedure for attaining truth untainted by cultural perspective, then, with patient and diligent effort, this procedure might eventually provide a ground for all truth. This, in turn, relegates the sociology of knowledge to the study of false belief, to belief which is not grounded in this universal, apodictic procedure.

As Bloor (1986) points out, mathematics and logic have been the most stubborn obstacles to strong social constructionist arguments. Classical work in the sociology of knowledge has tended to avoid the issue. For instance, Mannheim (1936: 298) considered mathematics to be a sphere of "truth in itself," an abstract and universal form of knowledge that stood outside of any particular ideology. And Berger and Luckmann (1966) theorize the social "logic" of institutions but never the institutions of logic and math.

But the distinction reinforced by these theories between universal and true domains of knowledge and constructed domains creates an unproductive dialectic. Math and logic are hypothesized to stand apart from all empirical knowledge, with no possible connection between these perfect forms and practical knowledge. Math and logic become meaningless, having no reference to anything in the world, and empirical knowledge becomes meaningless because it has no native structure. But, as with all dialectics, they cannot really be separated. As soon as we actually try to *use* either type of knowledge, we find ourselves enmeshed in the other.

Bergesen (2004a) rightly points out that the growing literature on infant cognition provides a new perspective on this fundamental debate in the sociology of knowledge. However, I don't believe his analysis goes far enough. Instead of attributing the categories of thought to infants, the research suggests that we must move beyond this constructionist/nativist dichotomy.

NUMERICAL CONCEPTS

Bergesen cites several well known studies which show that young infants are surprised by events that are mathematically impossible. For instance, Wynn (1992) showed infants a toy and then placed it behind a screen. Next, she repeated the process and placed a second toy behind the screen. The screen was then removed revealing either the expected amount (two toys) or a surprising amount (one toy). Because the infants looked longer at the improbable condition, Wynn deduced that the infants expected the mathematically correct amount.[2] Replications varied the location to show that the infants weren't merely remembering object location (Koechlin, Dehaene, and Mehler, 1997) and even altered the identity of the objects behind the screen (Simon, Hespos, and Rochat, 1995) yet the infants' numerical expectations were unchanged. Moreover, numerical thinking isn't limited to object perception. Bergesen cites several other studies demonstrating that infants have an awareness of number in regard to sounds (e.g., tones in Lipton and Spelke [2003]) and actions (e.g., the jumps and falls of a puppet in Sharon and Wynn [1998]).

These small number studies have been replicated often and clearly demonstrate an innate form of reckoning. Importantly, this type of numerical thinking is actually just one of *two* innate numerical concepts that infant researchers have discovered. The other (not mentioned by Bergesen in his discussion of number) is an analog magnitude system which supports the estimation of larger numbers. While both allow the non-socialized infant to engage in some numerical thinking, each system has significant limitations which prevent us from labeling either "number."

The first system, shown in the studies above, allows infants to track a small number of sets (Starkey and Cooper, 1980). Dubbed "parallel individuation" (Carey, 2009), this innate system allows infants (and, significantly, rhesus monkeys) to accurately compare quantity in sets up to about three. Beyond three, however, the system completely breaks down. Thus, presented with a choice between two containers of graham crackers 10- and 12-month-old infants will reliably choose the container with more in comparisons of 1 v. 2, 1 v. 3, and 2 v. 3. However, they choose at random in cases of 3 v. 4, 2 v. 4, and 3 v. 6 (Feigenson, Carey, and Hauser, 2002). Significantly, they even fail in cases of 1 v. 4, where the ratio should lend itself to easy discrimination (Feigenson and Carey, 2005).

The second innate number system, analog magnitude, allows for "guesstimates" of numbers far larger than the parallel individuation system can handle (Gallistel, 1990). However, this form of thinking has a fuzziness foreign to the concept of natural number. Whereas the primary characteristic of parallel individuation is its exactness when limited to sets containing one, two, or three objects, the defining characteristic of the analog magnitude numerical concept is Weber's law. According to Weber's law, the ability to discriminate two magnitudes is a function of their ratio. The greater the distinction between two magnitudes, the easier it is to distinguish them. Thus, it is easier to discriminate piles of two v. four items than eight v. nine since the first ratio is 1 : 2 and the second is a scant 8 : 9. Moreover, Weber's law predicts that the average error of estimates will increase in proportion to the magnitude of the set. Hence, the errors are going to be greater guessing how many individuals are in ballpark than how many are in a classroom.

This type of analog measurement is evidenced in a number of animal and human studies. For instance, while no one attributes natural number to rats, they show some rudimentary quantitative skill that conforms to Weber's law. In one experiment (Platt and Johnson, 1971), rats were trained to press a bar a set number of times to dispense food pellets (4, 8, 16, or 24 presses). In each condition, the mean number of presses the trained rats produced was slightly above the correct number with errors distributed around this mean. However, as the number of presses required increased, the standard deviation also increased. A similar study demonstrated rats' ability to discriminate both number of tones and their duration (Church and Meck, 1984). The errors made by the rats in this study also conformed to Weber's law.

Significantly, even pre-socialized infants have been shown to discriminate large numbers using an analog magnitude system which follows Weber's law. In a recent study (Xu and Spelke, 2000), infants were shown a sequence of displays containing 8 moving dots until they became bored. Then they were shown a new sequence with a different number of dots. They regained interest when 16 dots were shown, demonstrating an awareness of difference. This held even when density and brightness were controlled. However, they failed to regain interest when shown 12 dots. Thus, with a ratio of 1 : 2, the infants could discriminate large sets but when the ratio diminished to even 2 : 3, they failed.

To conclude, instead of an innate concept of number, the evidence suggests that there are likely two innate systems that involve numerical thinking. However, each is importantly limited and can be theoretically distinguished from natural number. Parallel individuation is limited to three (and, rarely, four) sets. Natural number involves an understanding of a successor function (i.e., that you can add "1" to any number to make it a larger set). The pattern of total collapse that characterizes parallel individuation beyond three indicates that children do not understand this rule. Analog magnitude estimation, on the other hand, can be used on larger quantities but a similar objection can be raised. A child can understand that one pile contains more items than another without also understanding that "more" involves a difference that is an exact amount. The reliance of the parallel magnitude system on the ratio of the piles indicates that this form of estimation utilizes a synthetic simplification which is clearly different than analytically distinct numbers.

From Numerical Concepts to Concepts of Number

Jumping from these forms of innate intelligence to explicit knowledge ignores the significant distinction between "numerical concepts" and "concepts of number" (Rips, 2011; Rips, Bloomfield, and Asmuth, 2008). Numerical concepts are innate forms of innate intelligence that involve the infant's tacit knowledge of number which is represented in action (e.g., surprise at a single toy when two should appear). A concept of number, on the other hand, involves the ability to abstract number from specific entities and make it an object of thought (e.g., the number "one"). Furthermore, it requires an understanding of the structure of number (i.e., that each number is distinct, separated by a distance of "1," that the system is infinite, etc.) (Leslie, Gelman, and Gallistel, 2008).

If the transition between numerical concepts and concepts of number were unproblematic, we could ignore the distinction and claim that the knowledge was there all along, just needing time to develop. Like geneticists, who refer to certain outcomes as innate even when a process of gene/environment interaction must occur, we can claim that abilities are truly native when their primitive, tacit form leads inexorably (given reasonably normal environmental conditions) to a universally shared, explicit adult version. If this were true, differences in performance based on age could be an issue of cognitive capacity and should demonstrate clear, linear development. The only reason why infants perform badly on complicated enumeration tasks (say, when the task involves reckoning 20 toys instead of 2) might simply be an issue of memory. In this interpretation, the infant has concepts of natural number but must develop the memory to utilize this knowledge.

Two sources of evidence militate against the hypothesis that natural number is continuous with either the parallel individuation or analog representation system.

First, evidence from child psychology indicates that learning to count isn't simply a process of accumulation. Instead, it occurs in laborious, single digit increments until about the number "three," before an "aha!" shift in thinking illuminates the relationship between number and counting (Carey, 2009). Both the difficultly in learning "one" through "three" and the sudden transformation raise important questions for the continuity hypothesis. If parallel individuation is the basis for natural number why does it take 6–9 months after they correctly use "one" for them to learn "two"? The studies already discussed clearly demonstrate that pre-linguistic infants already distinguish sets of objects from one to three, so why the effort to attach words to concepts they supposedly already possess?

Moreover, why do children only realize the relationship between counting and set size at $3^1/_2$ years of age? Infants younger than $3^1/_2$ are "subset knowers" who can only perform successful operations on sets of one, two, or three yet they become "cardinal principle knowers," unifying set size and counting and allowing for operations with greater numbers. This development is a qualitative shift in the child's understanding of number which is evidenced in a variety of behaviors (Carey, 2009). For instance, both subset and cardinal principle knowers can count items, but when asked "How much was that?," subset knowers rarely reported the last number of the count whereas cardinal principle knowers usually did. It is suggestive that before they become cardinal principle knowers, childrens' failures display the total collapse characteristic of the parallel individuation system. A child who knows "one" will give one object if asked, but if they're asked for two they will give between two and all of the remaining objects. If asked for three, those who know "two" will give between three and all the rest (LeCorre and

Carey, 2007; LeCorre et al., 2006). Thus, any unlearned number means "many" before the child learns that each number refers to an exact amount. The discontinuity in the development of verbal counting suggests that infants' numerical concepts are qualitatively different from natural number.

The discontinuity between numerical concepts and concepts of number is further highlighted in a second line of evidence. Anthropological research has shown that not all cultures have a concept of natural number. The Pirahã, a tribe indigenous to Brazil, use a number system which consists of (roughly) "one," (roughly) "two," and "many" (Gordon, 2004). Importantly, is appears that the lack of a cultural system of knowledge negatively affects the Pirahã's ability to perform mathematical tasks. When asked to match a set of 4–10 items with the same number of spools of thread, the Pirahã perform the task well. However, if the set is shown and then hidden, they make errors typical of the analog magnitude system (the standard deviation of these errors increase in proportion to the number of objects) (Frank et al., 2008). Hence, the Pirahã's lack of number words doesn't conceal underlying natural number knowledge.

Pica et al. (2004) have conducted similar studies with another Amazonian tribe, the Mundurukú, whose number system has no words for exact quantities beyond five. Like the Pirahã, the Mundurukú made systematic errors which conformed to Weber's law when they were asked to produce number larger than five.

The evidence from the Pirahã and the Mundurukú suggests that the development from innate numerical concepts to explicit number isn't a species-wide phenomenon. While both tribes show evidence of quantifying using both parallel individuation and analog magnitude systems, they do not have natural number and are, thus, constrained by the limits of those systems.

Taken together, these two lines of research provide strong support for the argument that, while some forms of numerical thinking may be innate, natural number surely isn't. Instead of a smooth, linear development from numerical concepts to concepts of number, the evidence demonstrates that the child undergoes a qualitative leap in order to grasp the concept of natural number. The path is discontinuous and the leap appears to be determined by whether one's culture has natural number as an existing domain of knowledge.

Of course, there is little doubt that numerical concepts develop during the course of the child's interaction with the world. In fact, many theorists have sought to ground the development of natural number in embodied action. Early work from Dewey (2008) and Piaget (1960) and more recent theory from Lakoff and Núñez (2000) and Mix (2002) have emphasized the continuity between motility and thought in an attempt to naturalize number. While these theories differ in some important respects, they share the belief that number emerges from our interactions with objects. A toddler gathering two balls is engaging in a primitive form of an embodied, enacted process of enumeration. Thus, number does not first exist as an abstract system which is imposed on the world but emerges within the child/environment interaction.

Yet, these theories face the same challenge that nativist theories face explaining cultures with limited numeral systems. Innate intelligence and embodied action may be necessary, but they not sufficient, for the development of concept of number. The Mundurukú and Pirahã certainly deal with objects, yet neither group has a concept of number. Without a pre-existing domain of knowledge, this development may never lead to natural number.

Are the Categories of Thought Social Constructs?

Is number socially constructed? This is clearly too simple a statement. It implies that the concept of number could vary in unpredictable ways, that each culture could develop its own unique and incommensurable number system. But this is not the case. The number system, when present, is unvarying. However, social technology clearly plays an important role in turning numerical concepts into concepts of number. In order to more fully understand the relationship between innate intelligence and explicit knowledge, we must understand what it means to attribute a domain of knowledge to an infant.

While infants demonstrate features of numerical thinking, simply attributing "number" to them glosses over a significant ambiguity. The concept of number itself has unclear boundaries. To what are we referring? Numerical concepts? Positive integers? Natural numbers? Rational numbers? Real numbers? While these concepts of number are widespread and have fixed structures, they are not cultural universals. Moreover, many adults, even in cultures with many years of required schooling, misunderstand aspects of number (e.g., fractions and irrational numbers).

Furthermore, learning new forms of number may not even be a linear process. Some have argued that it requires a reorganization of concepts one had previously held. For instance, Carey (2009) argues that learning fractions does not merely "add on" to one's knowledge of number but "directly challenges children's initial and entrenched concept of number as counting number" (354). Instead of accretion, we may have a series of conceptual revolutions. Limiting the concept of "number" to any one hypostasized meaning cannot help but be arbitrary.

Few of our concepts, even the ones we hold to be most basic and universal, are clearly bounded. Claiming that infants have knowledge over these domains glosses over an important distinction between innate intelligence and explicit knowledge. Innate intelligence represents what Goldman (2006: 178) has called our "basic, intuitive ontology" and Piaget (1965: 221) labeled our "practical" or "sensory-motor intelligence." These are all of the constraints on our cognition that have emerged through evolution that leads us to conceive of the world as being populated by discrete objects and events, agents and non-agents, etc. Explicit knowledge, on the other hand, represents how these constraints have been codified by a particular social group in a specific domain. The evidence demonstrates that children have a good deal of innate intelligence. In this sense, the nativists are right. However, very little of what they have corresponds to explicit forms of knowledge. As I have shown in regards to number, parallel individuation and analog magnitude each share some features with natural number yet are clearly *not* natural number. Furthermore, left to their own devices, they may never lead there. In this sense, Durkheim was right. The stable system of ideas that society presents readymade to the child provides a significant resource for the development of even basic cognitive categories.

Towards a Richer Sociology of Knowledge

Variations of the Durkheimian position have emerged in recent years (Ernest, 1998; Watson, 1990; Bloor, 1986, 1987; Livingston, 1986). While differing in many respects, they share a common goal of grounding mathematics in the same sorts of social processes which give rise to more clearly cultural forms of knowledge. For instance, in the conclusion of his essay on the sociology of mathematics, Bloor (1986) contends that Wittgenstein's (1991) philosophy of mathematics offers a way to place math in the social domain:

> Perhaps the most significant conclusion is that mathematics can now be seen as invention rather than discovery [. . .] The conclusion so far is that Wittgenstein has presented and developed a very simple but potentially very profound idea. Mathematics and logic are collections of norms. The ontological status of logic and mathematics is the same as that of an institution. They are social in nature. An immediate consequence of this idea is that activities of calculation and inference are amenable to the same processes of investigation, and are illuminated by the same theories, as any other body of norms. (389)

Thus, mathematics differs from manners or the rules of baseball only in the rigidity of the norms maintaining its coherence.

However, these theories, while interesting and creative, have never been fully convincing. There is something immanent within mathematics and logic which makes them seem more universal and enduring than other types of knowledge. The feeling of apodictic certainty which Kant noted, the limited cultural variability, and the innateness of some mathematical abilities seem to give it more solid ground. Yet, simply flipping the argument over and labeling these domains transcendent or native just reproduces the same fruitless dialectic. Instead, the evidence demands that we make finer distinctions than the crudely drawn categories "natural" and "socially constructed."

If the categories are the necessary condition of social life it would reason there must be some universal capacities that allow individuals to grasp them. However, as Schmaus (2004) argues, the actual representations of these capacities vary. But we can now be more specific in explaining how and why they vary. Instead of simply citing cultural variation as evidence for the relativity of knowledge in a particular domain, it is useful to understand the specific forms of variation. The development from tacit intelligence to explicit knowledge occurs in different ways in different domains. I offer here a list of suggestions for the various roles that social influence has on the developing mind- facilitation, division, specification, and construction.

1. Social facilitation. We have seen that social technology is vital for an understanding natural number. However, the form of this technology is strictly limited to either being available for use or not. In the case of social facilitation, cross-cultural variation is limited to the creation, establishment, and maintenance of the domain of knowledge. It can be more or less elaborated, more developed in some areas and less in others, but it cannot be fundamentally restructured. Number and formal logic require facilitation. If they exist as forms of cultural knowledge, individuals can adopt them. If not, they may never develop.

Other, purely structural, domains of knowledge may also require social facilitation while allowing no variation along certain dimensions. For instance, there is evidence that basic geometric concepts exist in cultures which lack any explicit concepts of geometry. Dehaene and colleagues (2006) have discovered the use of concepts like lines, points, right angles, and parallelism in a tribe that has no explicit geometrical system. Thus, a formal geometric system may or may not exist in a culture but, if present, it cannot deviate from certain universal structural elements. These basic features serve as constraints to cognition in these domains.

However, it is important to note that almost as soon as we step off of the number line to get a fuller understanding of what the numbers *mean* in relation to the empirical world, we begin to see classifications that vary between cultures. Thus, although members of numerate cultures may count the same amount of items, the way they conceptualize the ontology underlying the division between objects can be different. For instance, Watson (1990), utilizing Wittgensteinian philosophy, has suggested that the meaning of number is dependent upon the non-discursive "language games" that are played in a particular "form of life." Thus, the meaning of number depends upon its praxis. Different cultural practices lead to different ways of understanding number. For instance, languages like English conceive of material objects as spatiotemporal particulars and sets as aggregates that are built up from these independent units in successive iterations. In this case, garden hoe is a spatiotemporally distinct object and a collection of hoes are added, one by one, to reach a count. She contrasts this with the West African language of Yoruba which conceives of material objects as sortal particulars and achieves number by subtracting individual members of the set from the set as a whole. Thus, they conceive of a garden hoe as "hoematter" and a collection as a bunch of "hoematter" that is divided into units to reach a count.

Moreover, the practices associated with number determine its usability. For instance, young, illiterate children who work as street vendors know little explicit math yet can carry out complex mathematical tasks during transactions (Cole, 2005). Lave (1988) has demonstrated a similar phenomenon in individuals who cannot perform certain mathematical calculations in an abstract setting but perform well in practical situations like grocery shopping.

Thus, there is a specific form of cultural variation in the domain of number. It is true that there are significant cultural differences in the ontology of number and its practical use. What number refers to and how it is used differs. However, despite differences in meaning, familiarity, and application, the structure of natural number doesn't alter from context to context. Cultural influence, in this domain, is limited to either providing or not providing this unchanging structure.

2. Social division. In several domains, our senses provide us with continua which afford no natural classification. Since we cannot "cut up each kind according to its species along its natural joints" (Plato 1997: 542) in continuous domains, we often impose a structure upon them. The logic underlying such division is often founded upon principles of even distribution and distinction. These suggest that, in continuous domains with no "natural joints," categories are more or less equally allotted in order to maximize ease of discrimination. However, while such categories may be arbitrary, as they become institutionalized, they become increasingly intractable.

The structure of these domains follows a Saussurian logic (Saussure, 1972) which suggests that a fundamental quality of signs is that they are distinguishable from each other. For instance, the actual shape of the lowercase "l" is irrelevant as long as it is perceptually different enough from "i," "t," and "h" to be easily differentiated from them. Cultural differences in domains of social division and classification are limited to the number of categories, their distance from each other, and their degree of precision.

For instance, since there are no "natural joints" in the domain of pitch, the exact placement of middle A has fluctuated over time (Ellis, 1968). The current convention of defining middle A as 440 Hz is a rule which has evolved and only slowly gained acceptance. Moreover, the number of notes between octaves differs in different scales. However, despite the absolute difference in pitch and differences in the number of notes in different scales, the relative distances between notes always remains equal.

It is important to note that many of these domains may be naturally punctuated by environmental features which influence division and classification. For instance, distance may be discussed in terms of significant boundaries (e.g., property lines, waterways). Other domains may be punctuated by certain regular features of experience. For instance, certain colors may have salience due to their frequent presence. Berlin and Kay (1969) looked at color terms in 20 languages. Although they found differences in the number of basic color terms, among languages with the same number of terms, they found surprising harmony among them. Languages with only two basic color terms tended to use "white" and "black" (or "lightness" and "darkness" [Rosch, 1972]). Those with four tended to use "white," "black," "red," and either "yellow" or "green." According to Kay and McDaniel (1978), a culture's color schema grows by first naming the salient difference between light and dark and then including primary colors.

However, even when continuous domains are punctuated by salient phenomena, the need often arises to divide the area between the boundaries or to develop structures which display regular features over the entire domain. This necessitates the imposition of an arbitrary structure atop a domain. Regier, Kay, and Khetarpal (2009) have suggested that this process undergirds more sophisticated types of color classification. They have argued that color systems tend to be anchored by certain saturated portions of the perceptual "color space" which is then filled out with basic categorization mechanisms which divide and label the space between the saturated colors.

3. Social specification. In some cases, forms of native intelligence find culturally specific expression (we may consider these "underspecified universals" to distinguish them from the specific cognitive attributions made by strong nativists. Zerubavel (1997) has chronicled many domains in which universal human needs become channeled into diverse culturally appropriate forms. For instance, while all humans must eat and all food shares certain chemical features, there is cultural disagreement regarding what qualifies as food. Similarly, while certain universal biological processes undergird procreation, forms of accepted sexuality vary.

Social specification is a particularly neglected category in social science because its implied nativism seems particularly hostile to a strong social constructionism. However, work in developmental psychology has convincingly shown that presocialized infants do not simply aggregate meaningless perceptual data into more complex, cultural ideas but show a number of preferences from birth.

For instance, very young infants look preferentially at human faces. In her early work, Gibson (1969) argued that the interest in faces the infant evinces was simply a result of the many ridges of the face creating perceptually interesting areas of high contrast which, only later, become differentiated into individual faces. Twenty years later, however, she had changed her views considerably:

> We started at the wrong end of the stick [. . .] What is perceived first is the unanalyzed affordance of an event in which a caretaker and the baby are actors. This event involves a kind of interpersonal relation sometimes referred to as 'protocommunication'. The mother's voice and facial gestures are prominent in this event and are clearly responded to by the baby with coos and its own facial gestures. (Gibson, 1991: 611)

The event is meaningful from the beginning and does not require the accumulation of atomistic sensations.

However, these forms of innate intelligence aren't clearly specified at birth and, within some general parameters, can manifest in different ways. For instance, infants appear to have an innate tendency to attribute agency to objects that exhibit certain characteristics (e.g., independent motion, goal orientation, hands and eyes, etc.) (Carey, 2009). As they develop, this attribution undergoes a specification which has a degree of flexibility. There is between- and within-culture variation in whether agency can be applied to the dead or to deities, for instance (Cerulo, 2009). Recent technological advances in robotics and hyper-realistic computer programs further complicate the issue (Turkle, 1999).

While it is a significant area in which culture shapes the individual mind, social scientists should be especially careful when dealing with social specification. The distinction between innate intelligence and explicit knowledge make the delineation of these domains problematic. The intelligence the child has in the area of agency, for example, is a loose amalgamation of presuppositions. It doesn't correspond to any culture's notion of agency but becomes a coherent concept only through development. During the course of specification, both top-down (teaching, modeling, etc.) and bottom-up (learning by exposure) socialization processes concretize these native presuppositions into cultural schemas.

4. Social construction. Lastly, there is the category of social construction. There is voluminous literature on the theoretical basis and practical application of social constructionism. It has been usefully applied to research on social movements, health and illness, sexuality, race and ethnicity, and nearly every other area that social science investigates. However, the vast majority of this work does not address the boundaries of social influence and I will not dwell on it except to offer a definition of what constitutes a socially constructed object and to contrast social constructionism from facilitation, division, and specification.

If concepts are widely variable between cultures (either over time or across space) they may be considered socially constructed in the sense usually reserved for the term. Systems of governance, economic classes, and styles of music are cultural phenomena with historicity (a requirement of social construction). They have not always existed and they differ across cultures. Thus, they are not universal.

Social construction differs theoretically from the facilitation, division, or specification of innate forms of intelligence. Social construction differs from social facilitation in that it varies widely between cultures. It differs from social division in that it does not categorize a universal and continuous domain but actually creates and categorizes a new domain. And social construction is distinguished from specification since socially constructed objects are not based upon universal, but underspecified, concepts. Instead, during social construction, new concepts are developed through complex historical processes in which systems of references are established and then passed on to a new generation.

CONCLUSION

The evidence coming from cognitive and cross-cultural psychology demands we reexamine basic concepts in the sociology of knowledge. While theorists have addressed these issues through an ongoing critical discussion of Durkheim's social epistemology, few have done so from an empirical perspective. Certainly, much has been gained from this conceptual analysis yet this work has produced concepts which can be greatly clarified through a more thorough engagement with psychology.

Bergesen has utilized cognitive psychology to mount a novel attack on Durkheim's epistemology. The basic lesson of his argument- that we are born with a good deal of innate intelligence which cannot be attributed to social influence- is absolutely true and must be confronted. But, as I have shown, his conclusions were too simple. By not addressing the differences between the innate intelligence infants display and the explicit knowledge that is not yet present, he makes a strong nativist claim that is not justified. The path from innate intelligence to explicit knowledge is neither assured nor uniform. In some domains, for instance, pre-existing cultural knowledge must exist for innate intelligence to develop into explicit knowledge. In others, innate intelligence is little more than a messy set of perceptual preferences which get concretized into specific cultural representations. By looking into the specific patterns of growth in different domains, sociologists will be able to shed new light on some of the basic problems of the field.

Fifty years ago, Dennis Wrong (1961) criticized the oversocialized concept of mankind then prevalent in sociology. He concluded with this warning:

> I do not see how, at the level of theory, sociologists can fail to make assumptions about human nature. If our assumptions are left implicit, we will inevitably presuppose of a view of man that is tailor-made to our special needs . . . (192–93)

Such a theory is bound to be overly zealous in its ambitions and grow increasingly isolated from the fields whose object of study is the nature of the human animal. In engaging these fields, a project which is still in its infancy, we see how little the fears of reductionism are justified. Social constructionism, with its still potent insight into the nature of meaning, can only become more relevant when we understand its roots and limits more fully.

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NOTES

[1] Two objections can be addressed at the outset. First, that quantity and number are not clearly distinguished. In the introduction to *the Elementary Forms*, Durkheim explicitly relates his study of the categories of thought to both Aristotle and Kant's categories. Much of this paper is concerned with number and numerical thinking which is related to the category "quantity" in the philosophies of both Aristotle and Kant. Yet, the relationship between quantity and number is not obvious. For instance, for Kant, quantity was a prerequisite of all human thought. This seems quite distinct from the rather circumscribed role of numbers. There has been a good deal of empirical research regarding this topic and the distinction between quantity and number will be addressed in the discussion of innate intelligence and explicit knowledge.

Second, as Rawls (1996) points out, Durkheim actually produces a list of categories that is different from both Aristotle's and Kant's. This list includes only time, space, classification, force, cause, and totality. Durkheim did not explicitly address number as a category. She goes on to write that "Everything beyond the six categories falls within the province of the sociology of knowledge" (439) instead of a more foundational social epistemology. Using set theory, we can deduce number from his category of classification. It is not inconceivable that he viewed number as emerging as a byproduct of classificatory processes. Similar thinking is found in the modern discussion of the analog magnitude system that will be discussed later. Regardless, certain properties of number make it far more reasonable to conceptualize as a category than as simply a socially constructed piece of knowledge.

[2] Because it is so foreign to most social scientists, it is important to briefly discuss the experimental logic which undergirds many of these studies. Experimental paradigms which measure infant attention (i.e., looking time and dishabituation paradigms) were developed to introduce rigor to the study of a very hard to measure phenomenon. The basic principle underlying these methods is that infants look at what is interesting and novel and look away from things that are boring or redundant. For instance, a typical dishabituation experiment involves presenting infants with a scene until they grow bored (habituated) and then presenting either the same scene or a scene which differs along a single dimension, keeping the others constant. If the infant in the test condition regains interest in the scene, it indicates an awareness of the difference. Because they are dealing with infants, there is a good deal of "noise" in the data in the form of random behavior. However, as long as the noise is evenly distributed between both test and control groups, it shouldn't bias the findings.

Of course, interpreting just what the infant is aware of is difficult. For instance, altering the number of objects in a scene also alters the number of perceptual contrasts. Publication requires an increasing number of controls to limit alternative explanations. Having spent 18-months doing an ethnography of developmental psychology labs I can attest that the interpretation is still as much art as science. However, the findings discussed in this paper are among the most replicated studies in the discipline.

REFERENCES

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. New York: Anchor Books.

Bergesen, A. J. (2004a). Durkheim's theory of mental categories: A review of the evidence. *Annual Review of Sociology*, *30*, 395–408.

Bergesen, A. J. (2004b). Chomsky versus Mead. *Sociological Theory 22* (3), 357–370.

Berlin, B. O., & Kay, P. D. (1969). *Basic color terms*. Berkeley, CA: University of California Press.

Bloor, D. (1983). *Wittgenstein: A social theory of knowledge*. New York: Columbia University Press.

Bloor, D. (1986). Wittgenstein and Mannheim on the sociology of mathematics. In S. Shanker (Ed.), *Ludwig Wittgenstein: Critical assessments (Vol. 4)* (pp. 378–394). New York: Routledge.

Bloor, D. (1987). The living foundations of mathematics. *Social Studies of Science*, *17*, 337–358.

Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge: Cambridge University Press.

Carey, S. (2009). *The origin of concepts*. Oxford: Oxford University Press.

Cerulo, K. A. (2002). Establishing a sociology of culture and cognition. In K. Cerulo (Ed.), *Culture in mind: Toward a sociology of culture and cognition* (pp. 1–12). New York: Routledge.

Cerulo, K. A. (2009). Nonhumans in social interaction. *Annual Review of Sociology*, *35*, 531–552.

Church, R. M., & Meck, W. H. (1984). The numerical attribute of stimuli. In H. L. Roitblatt, T. G. Bever, & H. S. Terrace (Eds.), *Animal cognition* (pp. 445–464). Hillsdale, NJ: Erlbaum.

Cole, M. (2005). Cross-cultural and historical perspectives on the developmental consequences of education. *Human Development*, *48* (4), 195–216.

Coser, L. A. (1971). *Masters of sociological thought: Ideas in historical and social context*. New York: Harcourt.

Danziger, K. (1997). The varieties of social construction. *Theory & Psychology*, *7* (3), 399–416.

Dehaene, S., Izard, V., Pica, P., & Spelke, E. (2006). Core knowledge of geometry in an Amazonian indigene group. *Science*, *311*, 381–384.

Dewey, J. (2008). *Logic: The theory of inquiry*. Carbondale, IL: Southern Illinois University Press.

DiMaggio, P. (1997). Culture and cognition. *Annual Review of Sociology*, *23*, 263–287.

Durkheim, E. (1995). *The elementary forms of religious life*. New York: Free Press.

Durkheim, E., & Mauss, M. (1967). *Primitive classification*. Chicago: University of Chicago Press.

Ellis, A. J. (1968). *Studies in the history of musical pitch: Monographs by Alexander J. Ellis and Arthur Mendel*. Amsterdam: De Capo Press.

Ernest, P. (1998). *Social constructivism as a philosophy of mathematics*. Albany, NY: State University of New York Press.

Feigenson, L., & Carey, S. (2005). On the limits of infants' quantification of small object arrays. *Cognition*, *97* (3), 295–313.

Feigenson, L., Carey, S., & Hauser, M. D. (2002). The representations underlying infants' choice of more: Object files versus analog magnitude. *Psychological Science*, *13*, 150–156.

Frank, M. C., Everett, D. L., Fedorenko, E., & Gibson, E. (2008). Number as a cognitive technology: Evidence from Piraha language and cognition. *Cognition*, *108* (3), 819–824.

Fleck, L. (1935). *Genesis and development of a scientific fact*. Chicago, IL: University of Chicago Press.

Freese, J. (2008). Genetics and the social science explanation of individual outcomes. *American Journal of Sociology*, *114* (*Suppl.)*, S1–S35.

Freese, J., Li, J. A., & Wade, L. D. (2003). The potential relevances of biology to social inquiry. *Annual Review of Sociology*, *29*, 233–256.

Gallistel, C. R. (1990). *The organization of learning*. Cambridge, MA: MIT Press.

Gibson, E. J. (1969). *Principles of perceptual learning and development*. New York: Prentice Hall.

Gibson, E. J. (1991). *An odyssey in learning and perception*. Cambridge, MA: The MIT Press.
Godlove, T. F. (1989). *Religion, interpretation, and diversity of belief: The framework model from Kant to Durkheim and Davidson*. New York: Cambridge University Press.
Goldman, A. I. (2006). *Simulating minds: The philosophy, psychology, and neuroscience of mindreading*. Oxford: Oxford University Press.
Gordon, P. (2004). Numerical cognition without words: Evidence from Amazonia. *Science, 306* (5695), 496–499.
Hacking, I. (2000). *The social construction of what?* Cambridge: Harvard University Press.
Kay, P. D., & McDaniel, C. K. (1978). The linguistic meanings of basic color terms. *Language*, *54*, 610–646.
Koechlin, E., Dehaene, S., & Mehler, J. (1997). Numerical transformations in five-month old infants. *Mathematical Cognition*, *3*, 89–104.
Lakoff, G., & Núñez, R. (2000). *Where mathematics comes from: How the embodied mind brings mathematics into being*. New York: Basic Books.
Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge: Cambridge University Press.
LeCorre, M., & Carey, S. (2007). One, two, three, four, nothing more. How numerals are mapped onto core knowledge of number in the acquisition of the counting principles. *Cognition*, *105*, 395–438.
LeCorre, M., Van de Walle, G., Brannon, E. M., & Carey, S. (2006). Revisiting the competence/performance debate in the acquisition of the counting principles. *Cognitive Psychology*, *52*, 130–169.
Leslie, A. M., Gelman, R., & Gallistel, C. R. (2008). The generative basis of natural number concepts. *Trends in Cognitive Science*, *12* (6), 213–218.
Lipton, J. S., & Spelke, E. S. (2003). Origins of number sense: Large number discrimination in human infants. *Psychological Science*, *14*, 396–400.
Livingston, E. (1986). *The ethnomethodological foundations of mathematics*. London: Routledge & Kegan Paul.
Lizardo, O. (2007). "Mirror neurons," collective objects and the problem of transmission: Reconsidering Stephen Turner's critique of practice theory. *Journal for the Theory of Social Behavior*, *37* (3), 319–350.
Lukes, S. (1973). *Emile Durkheim: His life and work*. Standford, CA: Stanford University Press.
Mannheim, K. (1936). *Ideology and utopia*. New York: Harcourt, Inc.
Martin, J. L. (2010). Life's a beach but you're an ant, and other unwelcome news for the sociology of culture. *Poetics*, *38* (2), 229–244.
Mix, K. S. (2002). The construction of number concepts. *Cognitive Development*, *17*, 1345–1363.
Nietzsche, F. (1954). *The portable Nietzsche*. New York: Penguin Books.
Parsons, T. (1968). *The structure of social action*. New York: Free Press.
Piaget, J. (1960). *The psychology of intelligence*. Paterson, NJ: Littlefield, Adams & Co.
Piaget, J. (1965). *Sociological studies*. London: Routledge.
Pica, P., Lemer, C., Izard, V., & Dehaene, S. (2004). Exact and approximate arithmetic in an Amazonian indigene group. *Science*, *306*, 499–503.
Platt, J. R., & Johnson, D. M. (1971). Localization of position within a homogeneous behavior chain: Effects of error contingencies. *Learning and Motivation*, *2*, 386–414.
Plato. (1997). *Complete works*. Indianapolis, IN: Hackett Publishing.
Rawls, A. W. (1996). Durkheim's epistemology: The neglected argument. *American Journal of Sociology*, *102* (2), 430–482.
Regier, T., Kay, P., & Khetarpal, N. (2009). Color naming and the shape of color space. *Language*, *85* (4), 884–892.

Rips, L. J. (2011). *Lines of thought: Central concepts in cognitive psychology*. New York: Oxford University Press.

Rips, L. J., Bloomfield, A., & Asmuth, J. (2008). From numerical concepts to concepts of number. *Behavioral and Brain Sciences*, *31*, 623–687.

Rosch, E. (1972). The structure of color space in naming and memory for two languages. *Cognitive Psychology*, *3*, 337–354.

Saussure, F. D. (1972). *Course in general linguistics*. Chicago, IL: Open Court Classics.

Schmaus, W. (1998). Rawls, Durkheim, and causality: A critical discussion. *American Journal of Sociology*, *104* (3), 872–886.

Schmaus, W. (2004). *Rethinking Durkheim and his tradition*. Cambridge: Cambridge University Press.

Schutz, A. (1973). *Collected papers (Vol. 1): The problem of social reality*. The Hague: Martinus Nijhoff.

Sharon, W., & Wynn, K. (1998). Individuation of actions from continuous motion. *Psychological Science*, *9*, 357–362.

Simon, T. J., Hespos, S. J., & Rochat, P. (1995). Do infants understand simple arithmetic? A replication of Wynn 1992. *Cognitive Development*, *10*, 253–269.

Starkey, P., & Cooper, R. (1980). Perception of numbers by human infants. *Science*, *210*, 1033–1035.

Turkle, S. (1999). What are we thinking about when we are thinking about computers? In M. Biagioli (Ed.), *The science studies reader* (pp. 543–552). New York: Routledge.

Turner, S. P. (2007). Mirror neurons and practices: A response to Lizardo. *Journal for the Theory of Social Behavior*, *37* (3), 351–371.

Watson, H. (1990). Investigating the social foundations of mathematics: Natural number in culturally diverse forms of life. *Social Studies of Science*, *20*, 283–312.

Wittgenstein, L. (1991). *Remarks on the foundation of mathematics*. New York: Wiley-Blackwell.

Wrong, D. H. (1961). The oversocialized conception of man in modern sociology. *American Sociological Review*, *26* (2), 183–193.

Wynn, K. (1992). Addition and subtraction by human infants. *Nature*, *358*, 749–750.

Xu, F., & Spelke, E. S. (2000). Large number discrimination in 6-month-old infants. *Cognition*, *74* (1), B1–B11.

Zerubavel, E. (1997). *Social mindscapes: An invitation to cognitive sociology*. Cambridge, MA: Harvard University Press.