



Cultural context of cognitive development

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The cognitive problems that children formulate and solve in their daily lives necessarily take form in a cultural context. We review and illustrate two dominant approaches to study relations between cultural context and cognitive development, and we point to the limitations and affordances of each. Using a *dichotomous approach*, scholars employ a methodology that sharply differentiates cognition from cultural context, treating elements of cultural context as independent variables and elements of cognition as dependent variables. The approach often leads to propositions about transcultural features of context that influence the cognitive development of individuals. In contrast, using an *intrinsic relations* approach, researchers create units of analysis that capture relations between cognition and cultural context, investigating their mutual grounding in daily activities. We also review a small but important body of research that extends these approaches to diachronic analysis. This research seeks to understand shifting relations between cultural context and cognitive development over historical time. © 2014 John Wiley & Sons, Ltd.

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INTRODUCTION

As children participate in the activities of daily life—whether activities in the home, on the playground, or at school—they must solve problems, and through the process of problem solving, children construct new insights, representations, and understandings. Inescapably, these everyday problems take form in a cultural context. They are linked to purposes, institutions, strategies, tools, and semiotic systems, aspects of cultural life that have a history and significance in a community of people. But the utter familiarity of our own world means that often we do not notice the cultural embeddedness of everyday problems and the cognitive developments they occasion. This cultural context becomes more readily apparent when we consider communities that differ from our own, like children learning to count in remote Papua New Guinea communities that use body part counting systems, Refs 1–4, ancient Mesopotamian communities

in which scribes computed arithmetical quantities on cuneiform tablets,^{5–7} or in abacus training in Japan⁸ or China.⁹ In this article, we review some key orienting conceptual frameworks and empirical research that focus on relations between cultural contexts and cognitive developments.

We build on a number of research reviews on culture–cognition relations. Some reviews have adopted a disciplinary perspective, such as cross-cultural or developmental psychology^{10–20} and anthropology.^{21–24} Others are more topically focused, like reviews of research on everyday cognition^{25,26} or classroom contexts for learning.^{27–30} In this chapter, we draw connections between the approaches to research that undergird these prior reviews and an emerging body of work that extends these approaches. This new work focuses on diachronic analysis of cognition–context relations through extended periods of time.^{31–35}

We organize our review in three sections, each illustrating approaches to analyzing relations between cultural context and cognitive development. In the first, we describe *dichotomous* approaches. In these, scholars employ a methodology that sharply differentiates cognition from cultural context, treating

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elements of cultural context as independent variables and elements of cognition as dependent variables. In the second section, we describe *intrinsic relations* approaches in which cognition and context are taken as inherently related and mutually grounded in daily activity. Scholars using *intrinsic relations* approaches propose units of analysis that capture relations between cognition and context and investigate a range of empirical questions, often focusing on the way individuals draw upon their material, semiotic, and/or interpersonal worlds to organize their interactions and to mediate their problem solving.^{36–47} In the final section, we consider a small body of work that pursues what is often implicit in both of these strands of research: how contexts and cognition are each inherently in flux. We illustrate the way dichotomous relations³¹ and intrinsic relations³² approaches are being extended to incorporate diachronic analysis of shifting contexts and cognitive developments.

The distinction that we make throughout between the dichotomous and intrinsic relations approaches is not novel. The ‘dichotomous’ approach has been variously referred to by scholars reviewing the field as the ‘cultural influence’ perspective⁴⁸ or ‘cross-cultural psychology’.⁴⁹ What we term the ‘intrinsic relations’ approach falls under what some refer to as ‘cultural psychology’,^{10,49} the ‘cultural-historical’ method,^{45,50–53} ‘mutually constituting’ approach,^{54,55} or the ‘cultural practice’ approach.^{56,57} In distinguishing these two categories, we do not intend for them to be reified as absolute. Rather, we use them underscore important conceptual and epistemological tensions that have been—and still continue to be—relevant to work on culture–cognition relations.

DICHOTOMOUS APPROACHES: CONTEXT AS SURROUND, COGNITION IN THE HEAD

The metaphor that cultural context lies outside of and surrounds the cognitive processes of individuals captures well an approach that we are calling the *dichotomous* method. Fundamental to this approach is a methodological separation of culture, on the one hand, and cognition, on the other. This bracketing off of culture from cognition is done in the interest of measuring each of them separately and finding regularities in their co-relations. That way, causal inferences can be made about how aspects of the cultural context influence individuals’ cognitive developments.

Employing this approach, scholars have isolated for study numerous aspects of cultural context and investigated their effects on cognition. For example, researchers have investigated how cultural values may impact cognition. Researchers have argued that individuals from societies that stress respect for authority and social conformity have a different ‘cognitive style’ than those from cultural groups emphasizing autonomy.^{58–60} As another example, language has received considerable attention. Given significant typological variations in human languages, scholars have investigated whether speaking a particular language would impact nonlinguistic cognition. Researchers have indeed generated evidence that native speakers may conceptualize arenas such as time,⁶¹ spatial relations,^{62–64} motion,⁶⁵ and number⁶⁶ in ways that reflect structural features of their language.⁴

The scientific prospect held out by the dichotomous method is that, with sufficient corroboration, increasingly refined models can explain cognitive development as a function of contextual factors, regardless of the particular cultural setting. That is, the sought after insights into relations between cultural conditions and cognitive developments are intended to be transcultural. Given this aim, the selected measures of cognitive development—which, prototypically, are standardized laboratory instruments such as IQ tests—bear no obvious relation to either the aspect of cultural context being targeted or the particular population being studied. In anthropological terms, the dependent variable—the measure of cognition—instantiates an ‘etic’ rather than ‘emic’ perspective.^{67–69} The use of such standardized measures is a strategic choice, reflecting a paramount concern with methodological rigor: measurement instruments should have strong psychometric properties, be administered in uniform ways, and capture aspects of cognitive functioning that are ‘culture fair’ so that the effect of contextual elements on different groups can be compared. (In passing, we note, as other scholars have pointed out,^{10,70} that there is some irony in the use of IQ tests as culture free or context independent measures of cognitive development. IQ tests were originally developed with the expressed purpose of privileging the kinds of cognitive skills cultivated by Western European schooling.)

An Illustration of the Dichotomous Method: The Effect of Socioeconomic Status on IQ

The research on the relationship between socioeconomic status (SES) and cognitive development offers a particularly clear illustration of the dichotomous approach. One of the most extensively studied

constructs in the social sciences, SES is generally operationalized as a combination of income, parental education, and parents' occupational status.⁷¹ There has been a body of research that examines the effects of SES on cognitive development, treating SES (the independent variable) as a proxy for context and using IQ-based or other standardized assessments as measures of cognitive development (the dependent variable), e.g., Refs 72–74. A component of SES, poverty in particular has been shown to be associated with diminished performance on measures of cognitive development, with longer durations of poverty increasing this effect.^{75–78}

Drilling down into the specific causal mechanisms through which poverty contexts are associated with cognitive developments, investigators have used varied instruments as measures of context, one of which is the *Home Observation for the Measurement of Environment* (HOME). The HOME is based on observational and interview data of the child and primary caregiver. Researchers have included subscales of the HOME to show associations between lack of cognitive stimulation and diminished parental attentiveness with lower performances on cognitive measures.^{77,79}

The work of Guo and Harris,⁸⁰ which incorporates the HOME into statistical models, provides a particularly good exemplar of an attempt to drill down into causal mechanisms. The authors use structural equations generated from the National Longitudinal Survey of Youth (NLSY), which includes the HOME inventory, to determine the degree to which more specific variables account for the effect of poverty on measures of IQ. Figure 1 presents these variables (cognitive stimulation, parenting style, childcare quality, physical environment, health at birth, and childhood health) and schematizes the various possible causal links with cognitive development. The figure also lists a number of variables of interest that are assumed to be 'exogenous' to poverty (e.g., child's birth order), which are controlled for in the analysis. Based on their statistical model, the authors conclude that the effect of poverty on cognitive development is entirely accounted for by the variables. Furthermore, they conclude that the extent of cognitive stimulation^b is by far the most predictive of later IQ and hence provides the strongest causal explanation for poverty's effect on cognitive development. Thus, poverty is deleterious to cognitive development, so the argument goes, for the primary reason that it is associated with insufficient cognitive stimulation.

Chief among the strengths of the dichotomous method is that, in generating causal models, the approach has the potential to inform policy or engage

broad policy-relevant issues. One might easily imagine how findings like those of Guo and Harris could inform decisions in the public interest that attempt to increase children's early exposure to reading, policy that would be presumed effective regardless of the particular cultural context or population.

Clearly, there are undeniable affordances of making a clear separation between cognition and cultural context. That said, Hutchins⁴¹ captures well a problem with analytic approaches that dissociate cognitive developments of individuals from their social and cultural contexts. He argues that investigators' approaches to analysis should be structured in ways that 'do not leave important things unexplained or unexplainable' (p. 376). In this regard, we find problematic the way both contexts and cognition are separated and measured in the dichotomous approach to analysis, leaving much without the possibility of an explanation.

The crux of the problem is that separating cultural context from cognition and generating variables to capture each necessarily obscures the connections that each has to the other and their mutual grounding in children's daily activities. As a result, the mechanisms that bind context and cognition become targets of speculation. For example, motivating Guo and Harris' study was the well-established correlation between income, a contextual variable, and IQ, a cognitive-developmental variable. They attempted to determine which of the many proposed causal mechanisms account for the association. At first glance, their finding that lack of cognitive stimulation is the key factor seems to provide a satisfactory explanation: insufficient cognitive stimulation is deleterious to cognitive development. But when Guo and Harris' operational definition of cognitive stimulation is examined closely, it reveals itself to be—like poverty—yet another set of proxies. And herein lies the problem. Cognitive stimulation is measured by a host of additional proxies, like how often mother reads to child. What remains unexplained as well as unexplainable is the mechanisms whereby these individual proxies influence children's performances on IQ tests. The name of the variable remains a gloss for the authors' speculations about how these various proxies contribute to a single 'cognitive stimulation' mechanism.

To avoid the speculation that inevitably results from distancing context from cognition, what is needed, then, are methods that capture the mutual grounding of context and development in children's daily activities. In regard to this study, one might ask questions such as the following: What are the emergent properties of interaction whereby reading is accomplished? What are the contributions

Essential features of a structural equation model for the mediating mechanisms of the effects of poverty on intellectual development

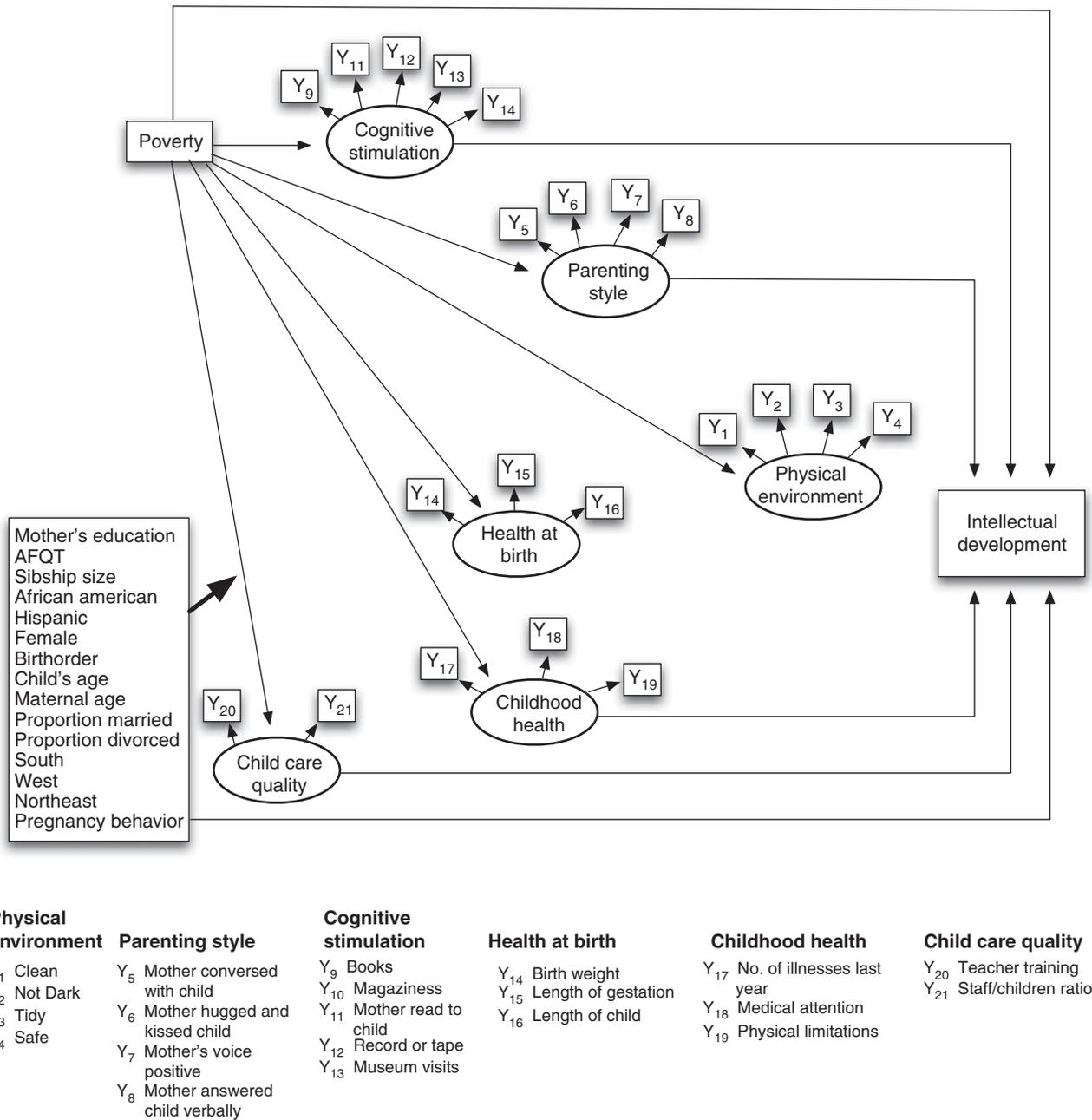


FIGURE 1 | Guo and Harris' model of poverty's effect on cognitive development.

that the child produces in processing the narrative? What are the contributions of the mother in supporting the child's efforts? How would the organization of the reading activity provide substantive insight into children's understanding of and performance on an IQ test; indeed, an IQ assessment constitutes a form of interactional activity in itself, with its own organization and repertoire of linguistic practices.^{55,81-83}

INTRINSIC RELATIONS APPROACHES: COGNITION AND CONTEXT RECIPROCALLY RELATED

We turn now to *intrinsic relations* approaches. These approaches generally follow Vygotsky's prescient psychological analysis articulated in the first half of the 20th century:⁴⁵ efforts to isolate cultural context and cognition to study their associations will not capture

core properties of either. To produce a more adequate approach requires, in Vygotsky's terms, a shift from an analysis by elements, which reflect a dissection of each independent of the other, to an analysis by units, which capture properties that inherently bind them together.⁴⁵ Vygotsky himself made use of multiple units, each of which provided particular directions to empirical inquiry. Examples of these include *word meaning* in his treatment of language and thought,^{44,45} the *zone of proximal development* in his treatment of learning–development relations,^{44,45} and *spontaneous/scientific concepts* in his treatment of inherent relations between instruction and development.⁴⁵ For Vygotsky, such constructs reflect both individuals' constructive activities and dimensions of cultural/social life (whether language, tools, social interaction, or the historical development of knowledge systems).

Many investigators have followed Vygotsky's lead. Leontiev, Vygotsky's student, built upon Vygotsky's concerns in proposing *activity* as a fundamental unit.⁵⁰ Leontiev's construct of *activity* coordinates broader levels of analysis (motive–activity relations) with more fine-grained levels of action (actions–goals relations; operations–conditions relations). In more contemporary scholarship using activity as a unit of analysis, researchers have elucidated the sociocultural matrix of institutional and interactional processes in which the activities of individuals are inherently situated.^{84–91} Others have emphasized the distributed properties of cognition. That is, rather than cognition being 'in the head' of a single person, cognitive work is accomplished as individuals work jointly with others or with tools and sign forms to accomplish problems. This idea was central to the work of Bateson³⁹ and has been elaborated in varied ways across formulations of cognition as a distributed activity.^{40,42,51,92}

Another overarching construct commonly used in contemporary analyses of intrinsic relations is that of a *cultural practice*—recurring, socially organized activities in which participating individuals solve problems.^{10,55,56,92–97} Studies have targeted diverse cultural practices and associated cognitive developments. Examples include the spatial understandings children develop in weaving, whether with back strap looms in Chiapas,^{98,99} straw weaving in Northeastern Brazil,¹⁰⁰ or rug weaving on looms among the Navaho.¹⁰¹ In the case of young children, investigations include numerical practices with which parents engage children growing up in middle and working class home settings.¹⁰² Others focus on children's engagement with abacus practices in Japanese after-school programs,⁸ as well as adults' participation

in practices like carpet laying¹⁰³ and those associated with carpentry and other trades.²⁶ A class of practices that received recurring attention by investigators involves economic exchanges in face-to-face interactions—the sale and purchase of commodities between vendors and customers. Economic exchange have been studied with individuals of different ages in Mumbai, India,¹⁰⁴ Recife, Brazil,²⁶ Oksapmin, Papua New Guinea,¹⁰⁵ Oaxaca, Mexico,¹⁰⁶ urban Nepal,¹⁰⁷ and in various parts of the United States.^{108–110} Across these studies, researchers have investigated practice-linked cognitive developments of individuals.

From a methodological standpoint, what distinguishes intrinsic relations approaches is the treatment of communities as case studies. Well-structured case studies afford different kinds of generalization than dichotomous approaches:¹¹¹ While case studies do not generalize to populations, they can contribute to theory building about the fundamental dynamics of culture–cognition relations. In turn, the resulting theoretical models can be tested and refined with new cases. In a case study, researchers may employ a variety of techniques. They may employ ethnography to understand the nuanced, socially organized world of community life and its relation to individuals' construction of novel cognitive developments. They may also employ statistical analysis, but using measures that are designed to capture and understand cognitive developments as they emerge in local contexts. Such a 'humble' approach, as it has been called by some,³⁰ is inherently local. It contrasts with the dichotomous approach that makes use of standardized measures designed external to the targeted context and independent variables conceived to be generalizable to any community.

We illustrate an intrinsic relations approach with a multi-method project conducted by Saxe on children who sell candy in Northeastern Brazil. Like other work, Saxe began the study with a focused ethnography, conducted in order to understand the practice and the mathematical goals that emerged for children through their participation. This ethnography then set the stage for focused studies on properties of sellers' practice-linked cognitive developments.¹¹²

The Ethnographic Task: Documenting Children's Emergent Goals in the Candy Selling Practice

In urban Northeastern Brazil, it was common to find boys selling candy in the streets. Children would buy boxes of candy of varying sizes from among many



FIGURE 2 | A boy computes what the gross price a wholesale box would yield if he sold candies to customers in the street at 4 for 1000 cruzeiros.

downtown stores and sell them at bus stops, outdoor cafes, and on sidewalks. At the time of the study (1985), the Brazilian economy was in a period of rapid inflation. The price of a wholesale box of 30, 50, or 100 candies ranged between Cr\$6000 to Cr\$20,000, and these prices surged at irregular intervals at each of more than 30 downtown stores. With fluctuating wholesale prices, sellers faced the mathematical challenge of marking up the price for retail sale. To determine a retail price, children also needed to accommodate to a prevalent selling convention: selling a certain number of units for either Cr\$500 or Cr\$1000. To compute the profitability of a candidate retail price (e.g., 3 candies for Cr\$500), sellers often removed all candy from their box and then returned the candies by the price ratio (see Figure 3), computing the sum and comparing it to the wholesale price they paid. Determining a 'good' retail price entailed comparing the profitability of different price ratios as well as contrasting one's own ratio with those other sellers were using (Figure 2).

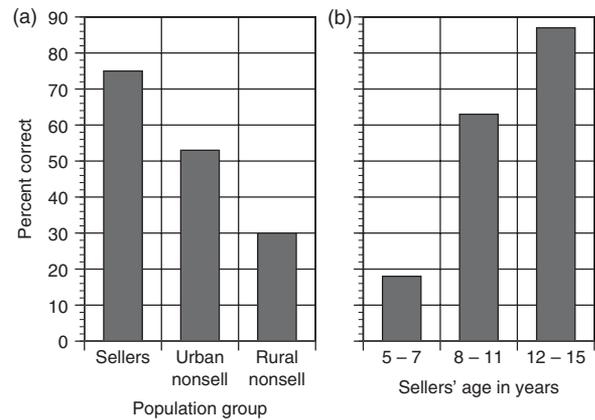


FIGURE 3 | Mean percentage correct on ratio comparison tasks as a function of (a) children's population group (10- to 12-year olds) and (b) sellers' age (in years).

The Task of Documenting Cognitive Developments: Generating Interview Techniques that Probe Practice-Linked Cognitions

To study more systematically the cognitive developments that emerged through participation in the practice of candy selling, interview tasks were developed. These are detailed in other publications (see Ref 112). As an illustration, consider one type of task that involved ratio comparisons. Sellers were presented with problems in which they had to determine which of two pricing ratios would yield a larger profit. For instance, a seller was told, 'Suppose that you bought this bag of *Pirulitos*, and you must decide the price you will sell the candies for in the street. Let's say that you have to choose between two ways of selling: selling 1 *Pirulito* for Cr\$200 or selling 3 for Cr\$500 (1 *Pirulito* was placed next to a Cr\$200 bill and 3 were placed next to a Cr\$500 bill). Which way do you think that you would make the most profit?' Children were also asked to justify their choice, if they did not do so spontaneously.

Drawing on such ratio comparison items, several studies were conducted to explore the cognitive developments that sellers might be generating through their participation in the candy selling practice, which are detailed in Saxe 112. In one study, the question was whether children's command of the kind of mathematics observed in the candy selling practice was due, in fact, to their participation in the practice or whether they were 'natural' developments. To address this question, three groups of children matched for age (between 10 and 12 years of age) were administered a battery of tasks like the one described above. The groups were candy sellers ($n = 23$), urban children who did not sell candy but were exposed to children's

selling activities ($n = 20$), and rural children who had less engagement with the money economy ($n = 17$). All children had minimal schooling (0–2 years). The results for the ratio comparison tasks are contained in Figure 3a. The figure shows that sellers performed at high levels of competence, with average percent correct about 75%. In contrast, urban and rural non-sellers did not develop the same understandings, with mean percentages at about 55% and 30%, respectively. Thus participating in the candy selling practice, and presumably conceptualizing and accomplishing emergent goals implicated in the practice, supported these cognitive developments.

Given that the ratio comparison understandings among sellers with little or no schooling were clearly linked to the practice, it raises the question of how these understandings actually develop with children's increasing participation in candy selling over time. Saxe found a rapid rate of growth in ratio comparison knowledge as a function of age group (see Figure 3b), with the younger groups tending to contrast ratios with attention to only a single value: either the number of candies exchanged, or the cost of candy. Older children were better able to coordinate the two values in comparing the price ratios. The age-based shifts in sellers' ratio comparison strategies make sense when considered in light of findings from the focused ethnography of the selling practice. On the basis of the observational studies, Saxe found that the candy selling practice had considerable tolerance for sellers of varying levels of mathematical competence. For instance, young sellers said that they received help in setting a price ratio and often offered their candy for only a single ratio (hence did not confront problems of ratio comparison).

Grounded in a focused ethnography of the mathematical problems that emerge for children in their practice, the study of candy sellers well illustrates some hallmark features of the intrinsic relations approach. In the study, cognitive tasks were designed to capture developments that appeared to be central to the ecology of the candy selling practice, like the comparison of ratios. Further, to support developmental analysis, structured comparisons were used that contrasted performance on the tasks among sellers of differing ages and same-aged children from the same geographical area who did and did not participate in the selling practice. The results, in turn, provided further insight into developmental processes, revealing well how children's accommodation to practice-linked conventions (like the price ratio selling convention) can support particular kinds of cognitive developments.

The study also reveals some of the limitations of the intrinsic relations approach. For example, the

findings are specific to the candy sellers, a population living in a particular area of Northeastern Brazil. To generalize to other populations would require additional case studies that make use of the developmental constructs that emerged from the candy selling work, like the intrinsic link between cognitive developments and practices. Furthermore, like many studies of practice-linked cognitive developments, this study covers a limited range of historical time.

COGNITION AND CONTEXT IN FLUX

In this section, we review a small body of research on culture–cognition relations that incorporates an analysis of changes over historical time. Cultural contexts and individuals' cognitive developments are inherently in flux, regardless of the time scale. But the flux is brought into unusually clear relief when historical shifts are a focus.^{32,113–115} The first well-known empirical study adopting a diachronic approach was conducted by A. R. Luria (Vygotsky's student). His pioneering empirical analysis investigated relations between individuals' cognition and ongoing shifts in post-revolutionary Soviet society.⁵³ Using a cross-sectional method, Luria studied groups at varied levels of collectivization and documented associated shifts in kinds of reasonings. Recent research has rekindled a focus on history for understanding relations between context and cognitive development. This research has extended either a dichotomous approach^{1,31,116} or an intrinsic relations approach.^{34,35,117,118}

Cognition and Context in Flux: Dichotomous Method

In extending a dichotomous approach to a historical analysis, Gauvain and Munroe³¹ asked whether experiences associated with societal changes toward modernity lead to increases in the cognitive developments of individuals. This question was motivated by the 'Flynn effect': an observed worldwide increase in IQ in recent history.^{119,120} Their study was designed to test the conjecture that this trend is due to more cognitively demanding environments as a result of increasing modernization.

To make headway, Gauvain and Munroe used a cross-sectional approach. They contrasted diverse communities on a modernity scale. At one end of the scale, they used as focal populations people who lived in two small-scale traditional societies (one in Kenya and the other in Nepal); at the other end, they sampled two industrial societies (one in American Samoa and the other in Belize). They then used a range

of IQ-like items to assess the cognitive development of individuals in these populations.

The findings that Gauvain and Munroe produced indicated that the individuals from more industrialized communities do indeed perform more successfully on the IQ-like measures than individuals from small-scale traditional groups. Further, across communities, children's performances on the IQ-like measures showed the expected correlations with specific variables associated with industrialization (like the adoption of radios in homes, the use of *why?* questions with children, and the reduction of open fire cooking).

Extending a dichotomous approach to relations between cultural context and cognitive development, Gauvain and Munroe note that their findings are consistent with other studies that have investigated relations between cultural contexts and cognitive development. The conclusion the authors draw is that, as small-scale traditional communities shift to industrial societies, individual members advance in cognitive development. The advances, the authors argue, are due to the same contextual variables that correlate with cognitive development within any individual community (at any particular degree of modernization).

As the Gauvain and Munroe study illustrates, when the dichotomous approach is extended to diachronic analysis, a methodological focus becomes the way shifts in variables associated with material and cultural conditions predict shifts in cognitive variables. The intention is to establish relations that hold across all communities. In turning to the intrinsic relations approach to the analysis of change over time, the focus is notably different, as we discuss next.

Cognition and Context in Flux: Intrinsic Relations Method

The intrinsic relations approach, with its focus on the character of knowledge individuals generate through their participation in cultural practices, leads to very different questions about relations between context and cognitive development over history. For example, in the case of candy selling practice reviewed previously, one may ask: how were contexts of development transformed, like the emergence of the practice in an urban center in Northeastern Brazil? And, in the process of transformation, in what way were the activities of individuals inherently related to the emergence and shifting organization of the specific practice? How did norms emerge in the practice for selling candy in ratio form? Why not other conventions? How did child candy sellers' cognitions about ratios lead to the sustained reproduction of price ratios in the candy selling

practice? To address such questions, which presuppose intrinsic relations between cultural context and cognitive development, methods are needed that would coordinate historical analyses of shifting contexts with developmental analyses that capture the character of individuals' context-situated cognitive developments.

To illustrate how cultural history can be productively incorporated into analyses of cognitive development, we describe recent studies conducted with a remote Papua New Guinea group, the Oksapmin. The fieldwork with the Oksapmin was conducted in 1978, 1980, and 2001, and the complete analysis is contained in a recent volume, the *Cultural Development of Mathematical Ideas*.³²

The Oksapmin, like their neighboring Mountain-Ok groups, traditionally use a 27-body-part counting system for number (see Figure 4a), and there is no evidence that Oksapmin used arithmetic in prehistory. Traditional uses of the body system included counting valuables, tallying contributions to bride price, and communicating about cardinal or ordinal values in varied situations. In the 2001 fieldwork, however, a striking development became apparent: In talk, if one used the suffix '-*fu*' after a body part, a speaker conveyed that the value of the body part should be doubled—an arithmetic operation. For example, if one refers to the nose in the context of counting or stating a cardinal value, the communicated meaning is the equivalent of "fourteen." But if one does the same and uses the suffix, "*fu*", the meaning is 28 (see Figure 4b). This was a remarkable development. It meant that a network of interlocutors all came to make use of the word form in more or less the same way to refer to a mathematical idea alien in traditional life. How might this have occurred? The ethnographic task was to search for changing problem contexts that might have led to a shift in function of the *fu* word form.

Like the work with child candy sellers, Saxe and various associates (during different periods of fieldwork) used a mixture of methods in the project. These included analyses of archival patrol report records, ethnographic participant observation, interview techniques, and design of varied types of cognitive tasks. The documentation led to the following set of conjectures with associated empirical studies that provided corroborative support.

- (1) *Early uses of fu prior to contact.* In everyday speech, the early meaning of *fu* was a complete group of things. In the case of counting, the meaning of *fu* was incorporated into the body counting system such that a complete round

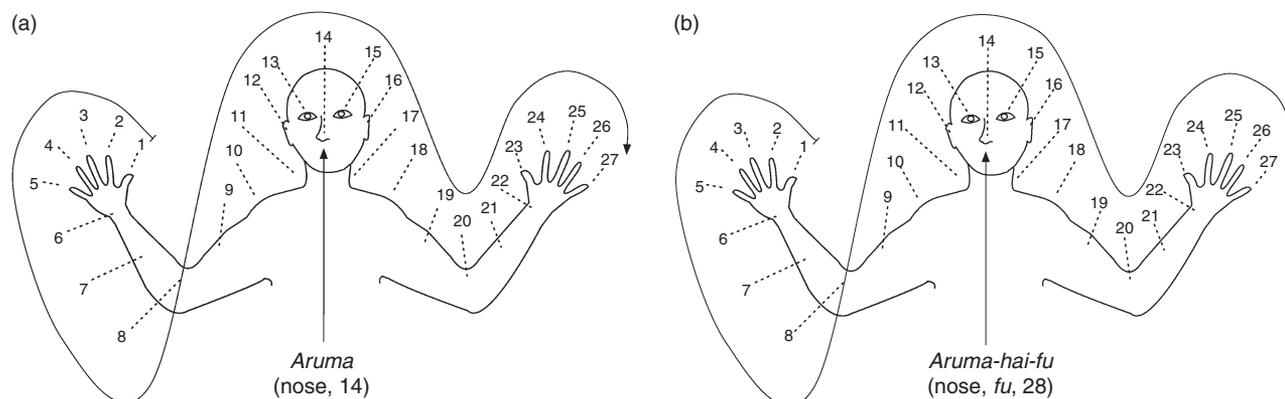


FIGURE 4 | (a) The Oksapmin 27-body part counting system. (b) The suffix *fu* to communicate a double of a body part's value.

of all 27-body parts was referred to as a *fu*, exclaimed with fists raised at the end of a count (see Figure 5).

- (2) *Introduction of currency (Australian pounds and shillings) post Western contact and the emergence of a new position of fu in a count.* With the emergence of a money economy and the use of Australian shillings and pounds, people counted shillings with body parts and generated equivalence relations in the context of exchanges, with 20 shillings (inner elbow on other side (20)) the equivalent of one pound. Eventually, a pound equivalent became a complete group of 20, or *fu!*, with a complete group becoming the inner elbow (20) in addition to the little finger (27) (see Figure 6).
- (3) *Shift in currency to Papua New Guinea's kina and toea and a shift in arithmetical function of fu in numerical expressions.* In 1975, the Papua New Guinea developed its own currency, the kina and toea, with a 2-kina note equivalent to one pound, and the 10 toea coin equivalent to one shilling. Based on these equivalences, people extended the familiar term for shillings to the 10t coin ('siling', i.e., shilling) and the term for pound to the 2-kina note ('faun', i.e., pound). *Fu* (referring to 1 faun) then also referred to a 2-kina note. This turn of events led to two alternative ways of counting 2-kina notes, as shown in Figure 7. One could count three 2-kina notes as 'middle finger (3) *fu*,' (3 fauns) or the equivalent of 6 kina, with one count a double of the other.
- (4) *The generalization of the doubling function of fu.* The use of *fu* to mean double the value of a body part when referring to 2-kina notes came to be generalized to other numerical contexts



FIGURE 5 | Woman completing all 27-body parts in the counting system, exclaiming *fu!* with fists raised at the count's end.

not directly related to counting 2-kina notes. For instance, an individual might refer to the sum of a 5-kina note and a 1-kina coin as middle finger (3) *fu*, even though there are no 2-kina notes to count (see Figure 8).

What this analysis demonstrates is that the development of new cognitive functions over historical time represent collective adaptations to new forms of daily activity. The illustration with *fu* points to the way people's efforts to communicate meanings in shifting contexts—like the new problems that emerge with shifting exchange practices and new currency tokens—lead to new cognitive adaptations. Thus, we find a shift in *fu* from its use to refer to a complete group of 27 body parts to a complete group of 20 body parts, to a doubling function for body parts. The process is one in which we find continuity and discontinuity over historical time: People reproduce but also alter prior uses of *fu* to support communication in interaction with shifting problems. In this way, the work

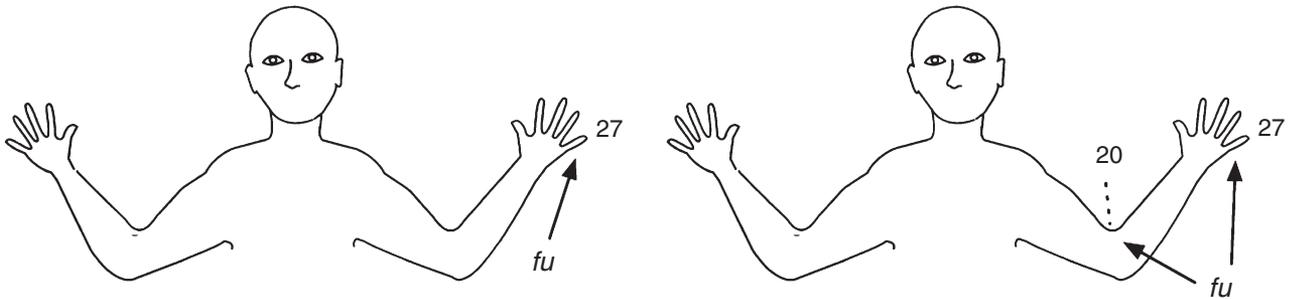


FIGURE 6 | Left panel: The early location for *fu* at the pinky (27). Right panel: A new location for *fu* at the inner elbow (20).

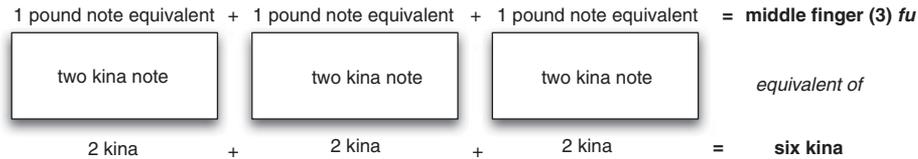


FIGURE 7 | *Fu* used as double the value of a body part when counting 2 kina notes.

provides insight into longstanding questions about the cultural origins of ideas.^{5,6,32}

The kind of diachronic analysis used in the example of *fu* contrasts in important ways with the dichotomous method used by Gauvain and Munroe. At a conceptual level, we return to the question of what is left unexplained or unexplainable. In the dichotomous approach, exemplified by Gauvain and Munroe, there is no room for analysis of how individuals may be agents of historical change. This is the case in two senses. First, by contrasting different communities ordered on a modernity scale, Gauvain and Munroe’s cross-sectional method leaves no possibility to explore the role of individuals as agents in the process of shifting societal contexts related to modernity. Moderization is treated as a process that occurs at a societal level, unrelated to the productive actions of individuals. Second, by using IQ as a dependent variable, Gauvain and Munroe provide no possibility to explore individuals’ roles as agents in the construction of new cognitive functions in the face of new kinds of problems over cultural history. Indeed, when treated as a dependent variable, an increase in IQ as a result of modernization leaves invisible the role of individuals’ daily activities as they generate new cognitive developments.

CONCLUDING REMARK

In this review, we have considered two prominent approaches to explore relations between cultural contexts and cognitive development. The dichotomous approach rests upon a methodological separation between context and cognitive development. The separation enables researchers to frame questions about how aspects of cultural context affect cognitive development, independent of a particular community. Sacrificed in this approach is the way culture and cognitions are mutually grounded in daily activity. Such an analytic move risks a distortion of both the character of cognitive processes as they are manifest in daily practices as well as the representation of cultural contexts as both shaping and shaped by the constructive activities of individuals.

The intrinsic relations approach is not without its challenges and limitations. Like the dichotomous, the intrinsic relations approach is limited in the generalizations that it affords. As mentioned previously, its very character leads to case studies of particular practices or communities rather than sampling techniques that lead to population-wide generalizations.¹¹¹ That said, the case study approach could support researchers’ efforts to elaborate theoretical frameworks that can be corroborated and advanced through successive cases. The intrinsic relations approach also comes with complex methodological and logistical challenges. Indeed, the approach often requires a coordination of ethnographic fieldwork and targeted studies, and these challenges are greatly magnified when communities are studied longitudinally.

Rooted in different epistemological commitments, intrinsic relations and dichotomous

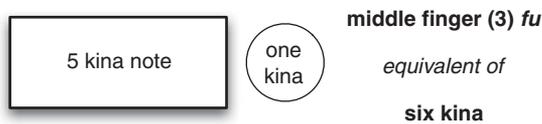


FIGURE 8 | *Fu* generalized to contexts that do not include 2 kina notes.

approaches are not easily reconciled. Without minimizing the tensions, we note that there are paths whereby these approaches could inform one another with regard to programs of work and empirical findings. Dichotomous approaches, for example, produce correlations between proxy variables for cognition and culture, and the correlations may bear on the interplay between cultural and cognitive developmental processes. Examples include studies that make efforts to capture relations between modernization and cognitive developments of individuals, operationalizing each as variables, as did Gauvain and Munroe. Finding relations between variables could well be a catalyst for a critical and grounded investigation that takes an intrinsic relations perspective: Building upon correlational findings, investigators could focus on each of multiple sites, seeking to corroborate, problematize, and flesh out the correlations. Though articulated in varied ways by some,¹²¹ this is an approach that is still underutilized in comparative studies. At the same time, dichotomous approaches may be well served by greater attention to the nuances of developmental processes as they take form in local ecologies, using appropriate, field-driven empirical techniques in efforts to interpret correlational findings.

Ultimately, we regard productive analyses to be those in which culture and cognition are treated—conceptually and methodologically—as mutually grounded in daily activity. Such an approach preserves the nuance in developmental processes as they occur in local contexts and, at the same time, could reveal generalizable constructs that may be useful in understanding relations between cognition and cultural context across communities.

NOTES

^a The research on language mentioned above exemplifies the dichotomous method in that it isolates language from other aspects of cultural context, treating it as an independent variable. At the same time, it also departs from the dichotomous method in that the measures of nonlinguistic cognition are designed to capture conjectured effects of the languages studied.

^b Cognitive stimulation is operationally defined as: (a) how often mother reads to child, (b) number of children's books in the home, (c) whether the child has a record or tape player, (d) how often the child is taken to museum per year, and (e) the number of magazines the family receives.

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