38 Historical Evolution of Intelligence

Patricia M. Greenfield

Intelligence Shifts Historically from Practical to Abstract

> Cole, Gay, Glick, and Sharp (1971) took an object-sorting task to Liberia, where they presented it to their Kpelle participants. There were 20 objects that divided evenly into the linguistic categories of foods, implements, food containers, and clothing. Instead of doing the taxonomic sorts expected by the researchers, participants persistently made functional pairings (Glick 1968). For example, rather than sorting objects into groups of tools and foods, participants would put a potato and a knife together because "you take the knife and cut the potato" (Cole et al. 1971, p. 79). According to Glick, participants often justified their pairings by stating "that a wise man could only do such and such" (Glick 1968, p. 13). In total exasperation, the researchers "finally said, 'How would a fool do it?' The result was a set of nice linguistically ordered categories – four of them with five items each" (Glick 1968, p. 13). In short, the researchers' criterion for intelligent behavior was the participants' criterion for foolish; the participants' criterion for wise behavior was the researchers' criterion for stupid.
>
> (Quote from Greenfield, 1997, summarized in Glick, 1974)

This quote encapsulates one of the most important trends in the history of intelligence: the shift from considering intelligence to be practical (Sternberg & Grigorenko, 2000) and contextualized to abstract and decontextualized. This quote refers to a cross-cultural difference. What is the justification to also call it a historical trend?

The answer begins with a definition of intelligence. "Successful adaptation to its own niche marks an animal form as intelligent" (Scheibel, 1996). In both Piaget's theory of cognitive development and Wechsler's psychometric approach to IQ testing, adaptation is central to the definition (Dasen, 1984; Greenfield, 1974/1976). However, neither Piaget nor Wechsler considers the possibility that adaptation may differ in different ecocultural settings (Berry, 1974).

By definition, abstraction implies distancing from the immediate context. Nonetheless, practical contextualized intelligence is adaptive in small, isolated, rural, subsistence communities in which members grow their own food, make their own clothes, and build their own shelters; education takes place in the locations where these subsistence skills are carried out and does not take place in school.

In contrast, abstract, decontextualized intelligence is adaptive in large, interconnected, urban, commercial, high-tech societies in which education takes place in school.

Intelligence, as defined in psychology, focuses on abstract, decontextualized intelligence. The overwhelming majority of psychological scientists assume the universality of this definition without understanding that abstraction is a cultural form. Abstraction as an important desideratum of intelligence is common to both Piaget – whose highest stage of cognitive development, formal operations, is also the most abstract – and to Wechsler, author of the most venerated and popular IQ test.

Historically speaking, small face-to-face agricultural villages existed before large urban centers and therefore practical intelligence existed before abstract intelligence. Therefore, cross-cultural differences between members of communities with the former characteristics and communities with the latter characteristics model long-term historical change in the definition of intelligence. The opening quote shows two extremes along the continuum. But note that practical intelligence still exists alongside abstraction in the United States; witness apprenticeship programs for manual skills like those used in construction work. I will return to this issue in my conclusion.

However, there are many intermediate points in the continuum illustrated in my opening quote; and social change can move cognitive adaptation along the continuum. Here, is an example from Luria's classic research of a shift in cognitive processing that implies a historical shift from practical intelligence to abstract intelligence:

The Soviet Union developed formal education in rural areas after the Revolution of 1917. Because of this development, learning environments came to include literacy and schooling. Luria (1976) compared farmers from remote villages in Central Asia without any school experience with participants having 1–2 years of school experience – and therefore basic literacy skills. Farmers with no schooling addressed Luria's problems as concrete practical situations. After a few years of schooling with basic literacy skills, they took a more abstract approach, separating their thought processes from the practical situation. Again, this comparison between schooled and unschooled farmers was a synchronic or cross-sectional model of what happened historically when print literacy and elementary schooling for children were introduced into the oral culture of rural communities.

Here, is a qualitative example of Luria's findings. Participants were shown drawings of a hammer, saw, log, and hatchet. They were asked, "Which ones are alike?" Rakmat was thirty-nine years old, had never been to school, and was illiterate. He groups items by their use in a practical context (Luria, 1976, p. 56):

RAKMAT: "They're all alike. I think all of them have to be here . . ."
LURIA: "But one fellow picked three things – the hammer, saw, and hatchet – and said they were alike."
RAKMAT: "A saw, a hammer, and hatchet all have to work together. But the log has to be here too!"
LURIA: "Why do you think he picked these three things and not the log?"
RAKMAT: "Probably he's got a lot of firewood, but if we'll be left without firewood, we won't be able to do anything."

Thus, Rakmat constructs a practical situation in which all the items are necessary. Similar to Glick's example in Liberia, "every attempt to suggest the possibility of categorical grouping met with protest: ‘That’s wrong. Some stupid fellow told you that, he doesn’t understand anything’” (Luria, 1976, p. 77). For this group, our definition of intelligent was their definition of stupid!

Contrast Rakmat’s responses with those of Yadgar, eighteen years old with two years of school experience; he has acquired basic literacy skills. He is shown drawings of a glass, saucepan, spectacles, and bottle and asked, “Which ones are alike?” Yadgar answers, “The glass, spectacles, and bottle all fit together. They’re made of glass, but the saucepan is metal.” He constructs a superordinate category – material – that is removed from the practical context of use. Luria’s quantitative analysis showed that Rakmat was typical of the group with no school or literacy experience, whereas Yadgar was typical of young people with one to two years of school and print literacy experience. In sum, the historical change of introducing literacy and schooling into a formerly illiterate environment with all education in situ produces decontextualized and abstract concept formation (Greenfield, 2019).

Computers continue this trend toward abstraction as technology advances. OLPC (One Laptop Per Child) is a US-based nonprofit organization that provides the world’s poorest children with laptops and software designed for independent learning. A field experiment in Ethiopia explored the effect of computers distributed by OLPC on the abstract reasoning of ten- to fifteen-year-olds (Hansen et al., 2012). In four schools, 202 children in Grades 5, 6, and 7 were given laptops (all the children in three schools, half the children in a fourth); these children were compared with 210 fifth, sixth, and seventh graders who were not given laptops (all the children in three sociodemographically matched schools and the other half of the children in the fourth school). Laptops were mainly used at home and during breaks at school; they were hardly used for teaching purposes in class. The most frequent computer activities were writing, reading, and gaming.

Students with laptops in the two older groups significantly outperformed their peers without laptops on two abstract reasoning tests – one tested analogies, the other categories. Examples of the two tests are shown in Figure 38.1. Note that the categorization test is a child version of Luria’s categorization problems, described earlier in the section. Interestingly, the effects of laptops did not improve school performance; instead, the laptop effects were specific to cognitive abstraction. Hence, the progression begun by print literacy and schooling, as shown in Luria’s studies, was continued by computer technology in the form of laptops (Greenfield, 2019). Because computers are a technology recently added to a preexisting ecology, this field experiment also models historical change in intelligence.

Why do schooling, print literacy, and computers stimulate the same shift in valued cognitive processes, that is, intelligence, from practical to abstract thinking? The answer lies in a theory of social change and human development.

Theory of Social Change and Human Development

This theory is interdisciplinary, integrating concepts from sociology, anthropology, and psychology. It is also multilevel, positing causal relations among the levels (Greenfield, 2009b, 2016, 2018). It incorporates sociodemographic variables at the top

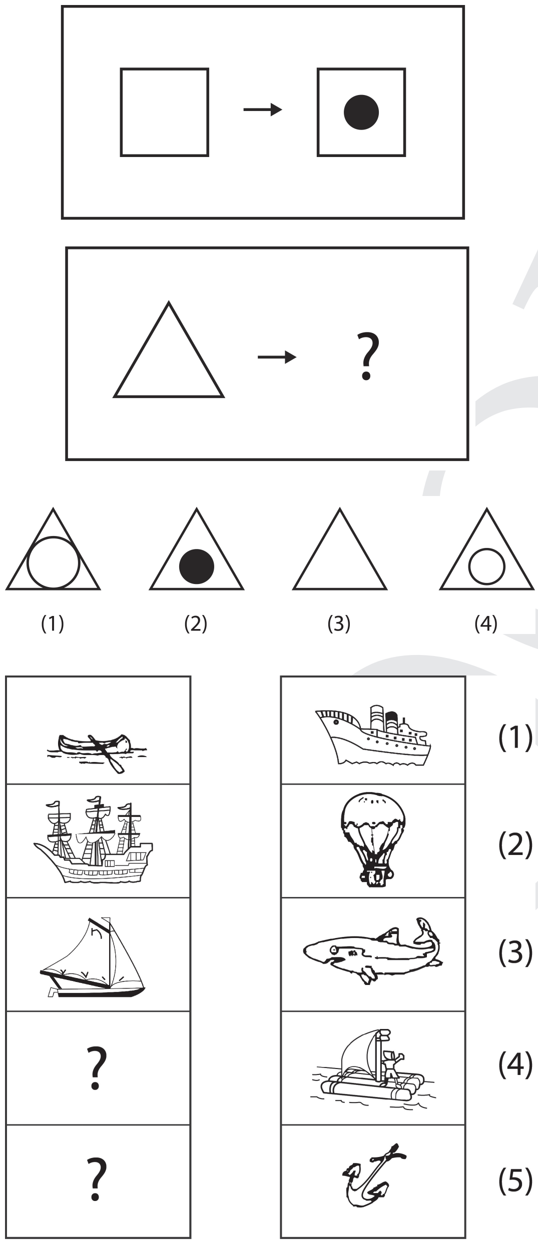

Figure 38.1 *Example of Analogies test and Categories test from the participant's point of view (from Hansen et al., 2012).*
Top: Example of Analogies test from the participant's point of view (the correct solution is alternative 2). By one or more changes to the figure to the left of the arrow in the top row, the figure to the right of the arrow is created. Children are asked which of the four figures in the bottom row should replace the question mark. The answer is given by applying the transformation in the top row to the middle row.
Bottom: Example of Categories test from the participant's point of view (the correct solution is 1 and 4). The child is asked which of the pictures 1–5 are from the same category as the three pictures on the left. In order to answer this question, the respondent has to discover the concept underlying the three pictures and apply them to novel images.

of the causal chain (with nineteenth-century roots in the German sociologist Tönnies, 1887/1957), cultural values at the next level down, learning environment at the next level, and individual development at the bottom (Figure 38.2).

Gemeinschaft (Community) and *Gesellschaft* (Society) summarize the features that anchor each end of the sociodemographic dimension (top level of Figure 38.2). Gemeinschaft denotes a small-scale social entity with all social relations based on close personal and lifelong ties – for example, extended family relations in a rural village; in contrast, Gesellschaft denotes a large-scale social entity with many relationships that are impersonal and transitory – for example, store clerks in an urban city. Each term, Gemeinschaft and Gesellschaft, summarizes a complex of sociodemographic elements. These features of Gemeinschaft and Gesellschaft provide anchors or endpoints for specific dimensions, listed on the sociodemographic level (top rectangle of Figure 38.2). All of the dimensions in the sociodemographic rectangle of Figure 38.2 tend to covary and shift together (Greenfield, 2018). The top horizontal arrow in Figure 38.2 denotes the dominant direction of globalized social change – from Gemeinschaft to Gesellschaft along multiple dimensions exemplified in the top rectangle.

We can think of Gemeinschaft features as being close to the environment in which human beings evolved. However, we have almost no "pure" Gemeinschafts left in the world. Most actual environments are somewhere in between the extreme endpoints on the various dimensions. The horizontal change arrows in Figure 38.2 therefore denote a *direction of movement*, not absolute locations on various scales.

Most important, the sociodemographic level (top rectangle, Figure 38.2) is at the top of the causal chain, influencing each lower level (vertical arrows from the Sociodemographic level to Cultural Values, Learning Environment, and Individual Development – lower three rectangles, Figure 38.2). Each lower level is influenced by and adapted to the ones above it (see the vertical arrows from the Cultural Value level to the Learning Environment, which includes socialization, and from the Learning Environment to Individual Development and Behavior).

So, when there is a shift on the top, Sociodemographic level from Community/ Gemeinschaft features in the direction of Society/Gesellschaft features, then there are correlated shifts on the lower levels of Cultural Values, Learning Environment, and Individual Development in the same direction; these shifts are denoted by the horizontal arrows in Figure 38.2. These are the historical changes. Note that all the historical shifts that are diagrammed did not take place simultaneously. A sense of timing will be given as the chapter progresses. The reader will also see that many historical changes in Cultural Values concerning intelligence are ongoing.

Each shift on a lower level is a theoretically driven prediction. Driven by sociodemographic change, these correlated changes on multiple levels constitute the heart of the theory of social change and human development.

Figure 38.2 is a guide to what follows in the remainder of the chapter; it lists the particular shifts on the levels of Cultural Values, Learning Environment, and Individual Development (bottom three rectangles of Figure 38.2) brought about by the global rise of cities, commerce, formal education, wealth, and communication technologies (right side of top rectangle in Figure 38.2). On the level of Cultural Values, the focus will be on values relating to intelligence (second level, Figure 38.2).

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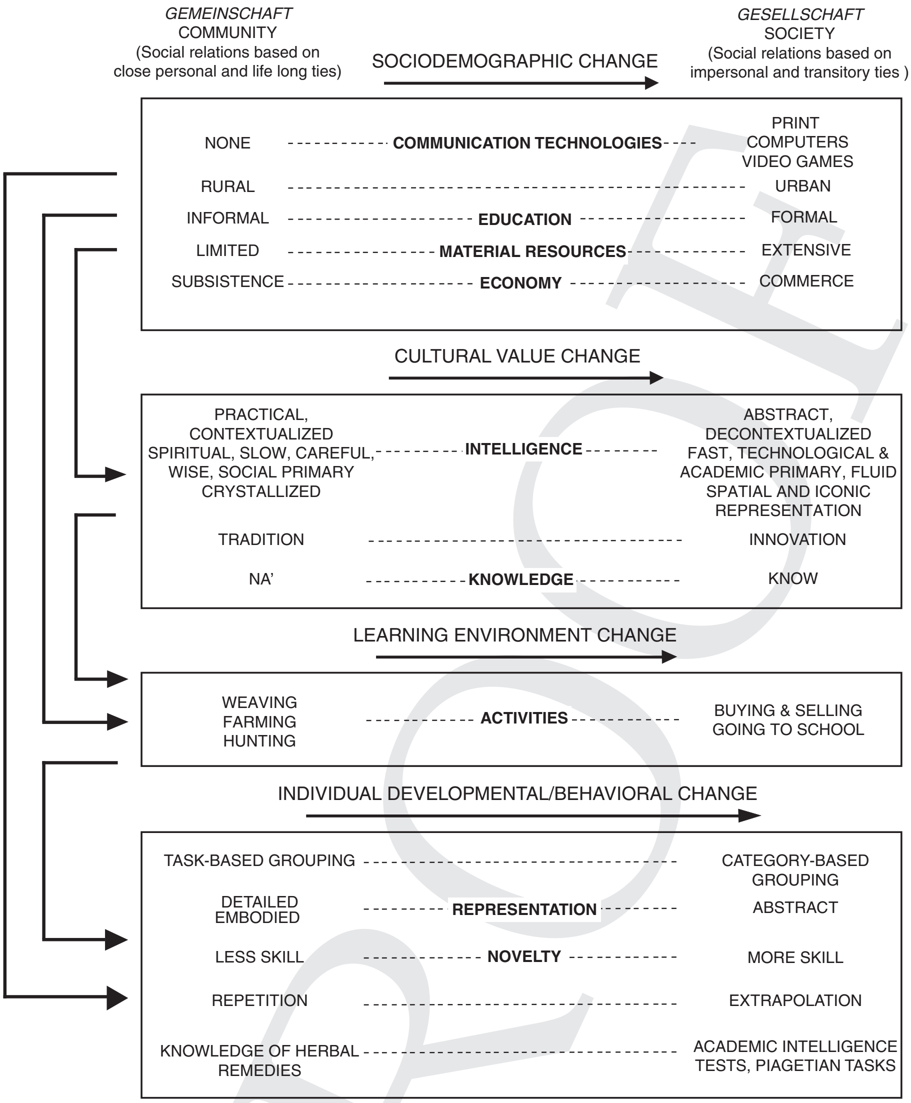

Figure 38.2 *Model of social change, cultural value change, and individual developmental change.*
Relationships for which there is empirical evidence, described in the text, have been selected for inclusion. While the horizontal arrows represent the dominant direction of social change in the world, sociodemographic change can go in the opposite direction. In that case, all the horizontal arrows would be reversed. The vertical arrows represent directions of influence, causal relations.

Both Sociodemographic shifts (top rectangle in Figure 38.2) and shifts in Cultural Values (second rectangle down, Figure 38.2) produce Learning Environment Change (third rectangle down, Figure 38.2), which in turn produces Individual Developmental Change (fourth rectangle down, Figure 38.2).

One relevant tenet of the theory is the equipotentiality of all of the sociodemographic factors in the top rectangle. It is this equipotentiality that explains why both schooling and computers stimulate the same direction of valued cognitive processes, that is, intelligence, toward abstract thinking. Equipotentiality means that when any sociodemographic variable moves from a more Gemeinschaft to a more Gesellschaft value, it will trigger the identical direction of change on a lower level – in this case from practical intelligence to abstraction. A corollary tenet is that whatever sociodemographic factor or factors is/are changing most rapidly at a given time or place will be the major factor(s) driving cultural and psychological change at that time or place. The shifts on all four levels depicted in Figure 38.2 furnish a guide to and summary of this chapter.

I begin with an overview of the sociodemographic level. The top level of Figure 38.2 depicts a global sociodemographic cluster that has been moving over time away from social relations based on close personal and lifelong ties (Gemeinschaft/Community) toward social relations based on more impersonal and transitory ties (Gesellschaft/Society) (Tönnies, 1887/1957). While moving historically in a common direction, the sociodemographic factors defining Gemeinschaft/Community (left side of top rectangle, Figure 38.2) cluster together and the sociodemographic factors defining Gesellschaft/Society (right side of top rectangle, Figure 38.2) cluster together (Greenfield, 2019; Santos, Varnum, & Grossmann, 2017). These patterns of intercorrelation and differentiation are all posited by the theory of social change and human development (Greenfield, 2009b, 2016, 2018).

From Tradition and Task-Relevant Detail to Innovation and Abstract Representation

The gold standard for drawing historical conclusions is diachronic evidence – data collected at different historical periods (Greenfield, 2018). So far, this picture of the shift in defining intelligence from task-relevant cognition to abstraction is based on historical inferences from synchronic evidence – comparative data collected in the same chronological period. This method provides indirect evidence. In contrast, historical studies that provide diachronic data provide direct evidence. A quasi-experimental study of pattern representation in three generations of children and adolescents in a Maya community in Chiapas, Mexico provides just such diachronic evidence concerning the shift from detailed, contextually relevant cognition to abstract representation and greater skill in solving novel problems (Maynard, Greenfield, & Childs, 2015) (see bottom rectangle of Figure 38.2).

The task was to place colored sticks in a frame to represent culturally central woven patterns (Figures 38.3 and 38.4). The first generation was assessed in 1969 and 1970 when the community economy was agriculture based. The second generation was tested in 1991, when the community economy had transitioned to commerce. This movement from a Gemeinschaft to a Gesellschaft ecology continued into the third generation, tested in 2012. The main sociodemographic change between Generation 2 and Generation 3 was an increase in school-based education (see top rectangle Figure 38.2).

Figure 38.3 *A nine-year-old girl places sticks in a frame to represent a red-and-white striped woven pattern.*
Photograph © Lauren Greenfield; original in color.

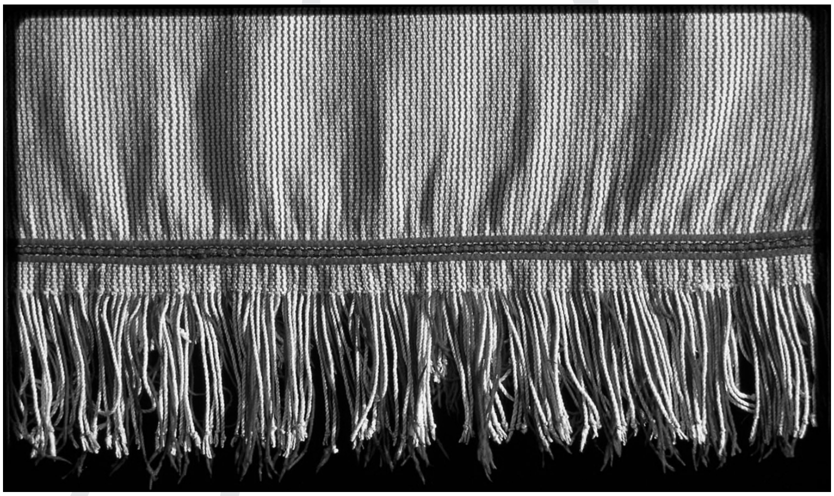

Figure 38.4 *Pattern of a Zinacantec man's red-and-white striped woven poncho (above) and a woman's red-and-white striped woven shawl (next page).*
Note that the shawl's wide red stripes are composed of three thin red lines separated by two thin white lines.
Photographs © Lauren Greenfield; originals in color.

Figure 38.4 *(cont.)*

The Role of Commerce

The historical shift from subsistence to commerce affected cognitive development, making it more abstract. From Generation 1 to Generation 2, there was a shift from detailed, thread-by-thread representation of woven patterns – the kind of representation required to actually create the woven textile patterns (Figure 38.5) – to more abstract representations (Figure 38.6) (diagrammed in bottom rectangle of Figure 38.2).

In addition to representing woven patterns, participants were asked to use the same apparatus to continue novel patterns, striped patterns that were unknown in the community. In addition to more abstract representation of familiar woven patterns in Generation 2, there was also a shift toward a greater ability to represent the novel patterns in the commercial period (diagrammed in the bottom rectangle of Figure 38.2). Note that novelty was a negative in the earlier period of subsistence, represented by Generation 1. If one made a textile that was "different," *t'oso* in Tzotzil, it was considered a bad thing. T'oso had the negative connotation of deviating from a norm. However, by 1993, with commerce established in the community, being different, that is, novel, in textile design was considered a positive (Greenfield, 2004). This value was much more in line with the importance of novelty in tests of fluid intelligence.

Structural-equation modeling showed that both these shifts – toward abstraction and skill in representing novel patterns – were driven by the participation of children and their parents in commercial activities (Greenfield, Maynard, & Childs, 2003). Commercial activities were distinguished from the older subsistence activities, such as males growing corn, females using the corn to make tortillas and weaving clothes for the family. (This shift is diagrammed in Figure 38.2; the links from a commercial economy to a Learning Environment that features buying and selling to abstraction

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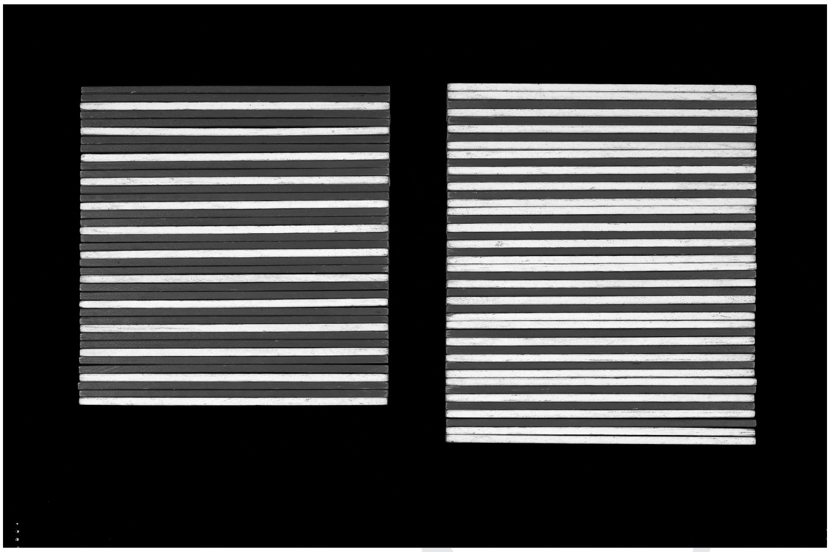

Figure 38.5 *A detailed, "thread-by-thread" representation of two Zinacantec woven patterns: a red-and-white striped poncho (left) and a red-and-white striped shawl (right).*
Photograph by Don Cole; original in color.

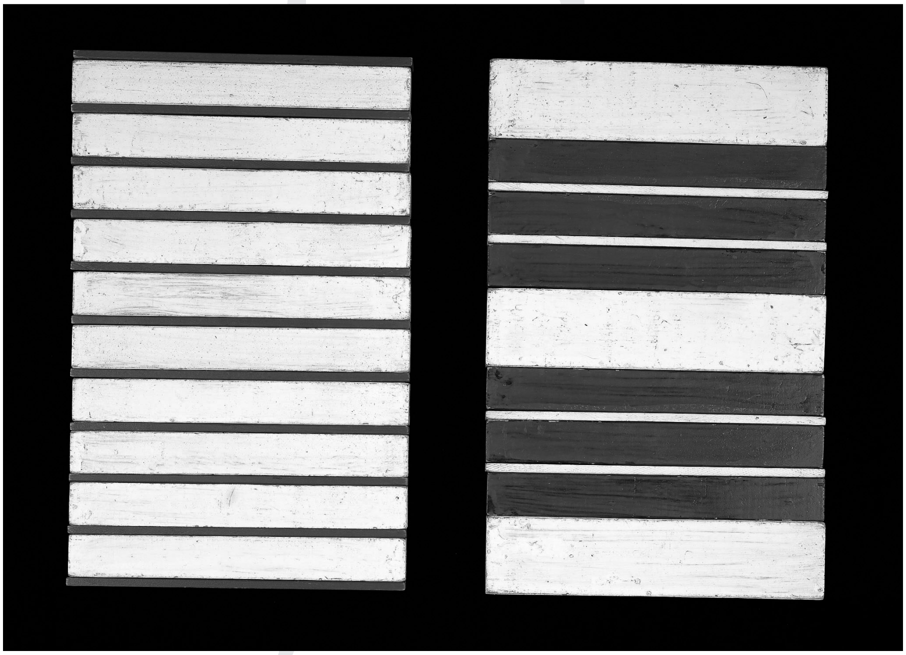

Figure 38.6 *An abstract representation of two Zinacantec woven patterns: a red-and-white striped poncho (left) and a red-and-white striped shawl (right).*
Photograph by Don Cole; original in color.

and skill with novelty is represented by the vertical arrow from the Sociodemographic rectangle to the Learning Environment rectangle to the Individual Development rectangle.) Commercial activities included both participation as a consumer – for example, having a television in the home – and participation as an entrepreneur – for example, a father buying and selling goods for a living. Innovation is valued in a commercial, entrepreneurial economy. Indeed, innovative (vs. traditional) pattern design had entered Zinacantec textile design in the twenty-one years between Generation 1 and Generation 2 (Greenfield, 1999, 2004) (diagrammed in the Cultural Value Change rectangle, Figure 38.2).

One novel pattern, the "growing pattern" (Figure 38.7), deserves description in more detail. Because it is so much like an IQ subtest, this pattern is of special interest as an example of the historical augmentation of fluid intelligence and "going beyond the information given" (Bruner, Goodnow, & Austin, 1956). Figure 38.7 shows the pattern and the three "correct" ways to continue it. The third way, making it grow (far right), would be assumed in our culture and, indeed, I was surprised in 1969 when almost no participants utilized this strategy. Instead, most participants who were old enough to deal with this, our most complex pattern, repeated the pattern (far left); the second most popular correct strategy was to make a mirror image (middle pattern), a strategy probably based on mirror-image borders on each side of a weaving (Greenfield & Childs, 1977; Greenfield et al., 2003). However, as commerce grew, the percentage of children using the growing strategy, compared with the other two correct strategies, increased from 18 percent to 62 percent (Maynard et al., 2015). More children were extrapolating, "going beyond the information given." This is a shift from repetition to extrapolation (diagrammed in the bottom, Individual Development rectangle of Figure 38.2). The connection of this change to a commercial economy is represented by the vertical arrow from the Sociodemographic rectangle to the Individual Development rectangle in Figure 38.2. To use the vocabulary of intelligence test development, Zinacantec children were moving, implicitly, in the direction of higher fluid intelligence; they were treating the pattern as a novel problem rather than something that was already part of their knowledge base (crystallized intelligence). The connection between the shift to a commercial economy and the shift toward fluid intelligence is represented by the vertical arrow from the Sociodemographic rectangle to the Cultural Value rectangle (Figure 38.2).

The Role of Formal Education

From Generation 2 to Generation 3, the increase in educational opportunity drove further increases in abstract representation of woven patterns and skill in continuing novel patterns (Maynard et al., 2015). At the same time, schooling came to replace weaving in the Learning Environment of Zinacantec girls (diagrammed in the third level of Figure 38.2); correlatively, detailed thread-by-thread representation of textile patterns was most frequent in girls with more varied weaving experience (diagrammed in the fourth level of Figure 38.2). This link is represented by the vertical arrow from the Learning Environment rectangle to the Individual Development

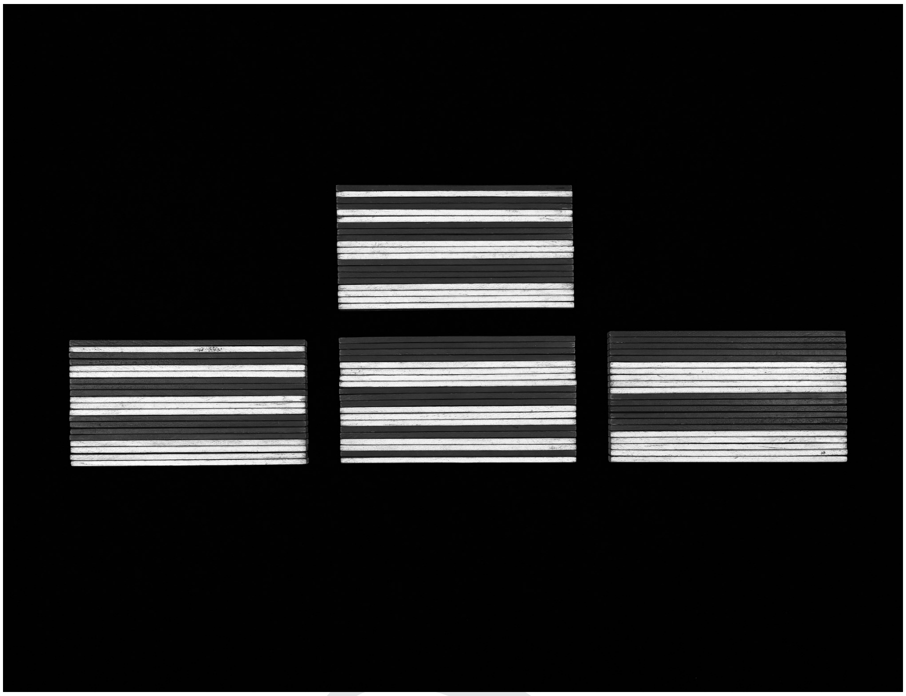

Figure 38.7 *Model for the growing pattern and three possible continuations. The experimenter's model is at the top and three possible "correct" responses appear at the bottom: repetition (left), mirror image (center), and progression (right). All stripes are red and white.*
Photograph by Don Cole; original in color.

rectangle. The type of intelligence required to weave, a historically ancient activity, was distinct from the type of intelligence that was useful at school or in commercial activities, historically newer activities. Across the generations, we see historical change in children's learning environments and in the way intelligence is tacitly defined. Through structural equation modeling, we were able to link learning environment change to tacit expressions of changing intelligence (Maynard et al., 2015).

From Embodiment to Abstraction in the Oksapmin Number System: The Role of Commerce

Saxe (1999) used different groups of adults studied at the same chronological time to link changing sociodemographics to changing learning environment to changing cognition. In the 1970s, the Oksapmin lived in a subsistence ecology of hunting and agriculture. Their number system was a totally embodied one. Body parts were used as numbers. For example, the same word was used for thumb on the right hand and for the number one. "Number cognition was tied to a specific context, the body; it was never abstracted from this context" (Greenfield, 2009, p. 408).

However, wage work on distant plantations with trade stores led to the introduction of trade stores into the Oksapmin environment. With trade stores came the introduction of money and commerce into the subsistence world of the Oksapmin, formerly based on farming and hunting.

> To adapt to the trade stores, Oksapmin people had to add and subtract for the first time. In this commercial environment, the contextualized system of using body-part names for numbers broke down. In adaptation, Oksapmin who were involved with trade stores as sellers or buyers started developing a slightly more abstract system that was usable for addition and subtraction; in this more decontextualized or abstract system, counting words were dissociated from the counter's actual body parts. (Greenfield, 2009b, p. 408)

(This relation between Learning Environment Change and Developmental Change is represented by a vertical arrow between the two rectangles in Figure 38.2). As the historical niche changed from subsistence to commerce (top rectangle, Figure 38.2), successful adaptation, our definition of intelligence, changed from contextualized to more abstract thinking (Cultural Value rectangle, Figure 38.2).

Tacit Knowledge and Practical Intelligence

So far, I have not dealt with explicit conceptualizations of intelligence; instead, I have dealt with tacit knowledge. But Sternberg and Grigorenko (2000) make the point that tacit knowledge is an aspect of practical intelligence. The definition of intelligence as successful adaptation to a niche means that all intelligent behavior is practical insofar as it is adaptive in a particular niche. And I have shown that, as ecological niches changed, so did the nature of practical intelligence and tacit knowledge. However, I will now switch to explicit conceptualizations of intelligence.

Inferring Historical Change in the Kiganda Conception of Intelligence

In Uganda, Wober (1974) explored the Kiganda concept of intelligence in a number of Baganda participants differing in sociodemographic characteristics. (Kiganda is the adjective; Baganda, the people.) By comparing explicit conceptions of intelligence in groups with different sociodemographic characteristics, we can infer historical change in the concept of intelligence.

Obugezi was the Kiganda language's word for intelligence. Village adults with limited primary schooling asserted that intelligent people are slow and careful; they also saw intelligence as spiritual, friendly, and public (Wober, 1974). Village teachers were a group with considerably more formal education. In contrast to other villagers, they saw intelligence as significantly more hurried, hasty, and unfriendly.

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(This relationship between the Sociodemographic level and the Cultural Value level is diagrammed in Figure 38.2).

These data came from a small agricultural community where, before schooling was introduced by a colonial power, most, if not all, education was in context: learning to do tasks at home or in the fields, learning one's kinship network. So I would make the case that being slow and careful is a component of intelligence in Gemeinschaft worlds more generally. In contrast, the measurement of intelligence in the Gesellschaft world (e.g., IQ tests) puts a premium on speed. I would interpret the difference in friendliness between the two groups as reflecting a greater emphasis on social qualities in a more Gemeinschaft world.

An urban group in Kampala, consisting mainly of teachers, saw intelligence as less spiritual, less careful, and more unfriendly than the other two groups. This group, with the most educational qualifications and living in the city, have gone the furthest in inhabiting a Gesellschaft ecology (top level, right side, Figure 38.2) and their definition of intelligence is adapted to this ecology (second level, right side, Figure 38.2). Because urbanization and formal education were later cultural steps for the Baganda, introduced through colonization, we can infer that the villagers, inhabiting a rural setting and having little formal education, represent an earlier point in time and that the influence of schooling and urbanization has led to historical shifts in the Kiganda concept of intelligence. (This causal relationship is represented by the vertical arrow from the Sociodemographic rectangle to the Cultural Value rectangle, Figure 38.2).

N'glouèlê: Integrating Social Intelligence with Technological Intelligence

Mundy-Castle (1974/1975) distinguished between social intelligence valued in Africa and technological intelligence valued in the West. He emphasized that social intelligence incorporated technical skills insofar as they contributed to the community. Similarly, Dasen, studying a Baoulé village in Ivory Coast, emphasizes that the Baoulé concept of intelligence, *n'glouèlê,* integrates cognitive and social skills, as do many other African concepts of intelligence (Dasen, 2011). Indeed, the most central (in the sense of agreed on) attribute for intelligent children listed by illiterate Baoulé farmers was "readiness to carry out tasks in the service of the family and the community," a social quality (Dasen, 1984, p. 426). For adults, "speaking well in public, knowing how to use proverbs . . . and wisdom . . . are also part of intelligence, but they cannot really be expected of children" (Dasen, 1984, p. 427).

"The more technological skills have to be integrated with the social skills. The child's abilities are useless unless they are applied for the good and well-being of the social group. It is in this integration of social and cognitive attributes that the Baoulé definition of intelligence is most at variance with the Western and psychometric definitions" (Dasen, 1984, p. 427). "What is particularly valued is the initiative in carrying out a needed task without being asked. The second most important attribute is . . . respect of elders, politeness, and compliance" (Dasen, 1984, pp. 426–427). These top child attributes are all social.

So social attributes are more important in Gemeinschaft-adapted intelligence than in our Gesellschaft world. Nsamenang (2003, 2006) and Serpell (2011) make the point that social responsibility is a dimension of intelligence in village settings throughout Africa. Serpell (2017) succinctly notes that, in Zambia, the Chewa concept of *nzelu* (glossed as intelligence) combines smartness with social responsibility. (The primacy of social intelligence in Gemeinschaft ecologies is shown on the left side of the Cultural Value rectangle, Figure 38.2.) I would make the case that these forms of intelligence also have a historical dimension: that the integration of social and technological intelligence is valued in Gemeinschaft environments and that these environments historically preceded Gesellschaft environments, the inhabitants of which place greater value on technological intelligence. It is significant that, in Dasen's (1984) research among the Baoulé, standardized Piagetian tasks of concrete operations, a measure of developing intelligence, created in Switzerland, correlated very strongly with school grades (in a sample of seven- to nine-year-old children) and with an IQ measure developed in the West (a subtest of the Queensland test) but not at all with Baoulé parents' or Baoulé assistants' assessment of children's n'glouèlê. Again, given that schooling, a Gesellschaft influence, was overlaid through European colonization on a prior oral culture with informal education at home, that is, a Gemeinschaft ecology, we can conclude that the qualities of n'glouèlê preceded in historical sequence the qualities of intelligence developed in the school and assessed by Piagetian tasks and IQ tests (shown on the right side of the Cultural Value rectangle, Figure 38.2).

The Historical Introduction of Schooling Develops Concrete Operations, the Piagetian Definition of Intelligence, in Middle Childhood

In line with Dasen's findings, between eleven and thirteen years of age, only about half the unschooled Wolof children in a Senegalese village were successful in solving Piaget's concrete operational tasks; these children were receiving informal education in home and community settings. In sharp contrast, all the schoolchildren in this age group and from the same village succeeded at the tasks. This study was done shortly after independence from France, when formal education was just starting to develop in bush villages and many children still did not attend school. However, schoolchildren in the village performed at the same level as schoolchildren in Geneva, where the tasks were developed, or the United States (Greenfield, 1966). Again, if these Piagetian tasks are taken as measures of developing technological intelligence, we must conclude that success by young children in solving them reflects the historically later introduction of formal schooling through the colonization of Senegal by the French. Recall, too, that formal education is an important component of a Gesellschaft ecology, whereas informal education at home and in the community is a characteristic of a Gemeinschaft ecology. Hence, the

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sociodemographic shift to the availability of a school in the community (right side, Sociodemographic rectangle, Figure 38.2) availed some children the opportunity to go to school (right side, Learning Environment rectangle, Figure 38.2), leading them to success on Piaget's tests of concrete operations (right side, Individual Development rectangle, Figure 38.2). (These causal relations are represented by the vertical arrows from the Sociodemographic rectangle to the Learning Environment rectangle and from the Learning Environment rectangle to the Individual Development rectangle, Figure 38.2.)

Serpell (2011) is very direct about the war between indigenous village-based conceptions of intelligence as "an amalgam of cognitive alacrity and social responsibility" (p. 128) and the school's exclusive emphasis on the latter:

> Since contemporary Western-style schooling in many African countries tends to assess children's educational progress almost entirely in terms of cognitive skills and knowledge acquisition, these findings have been interpreted as reflecting a serious credibility gap for public basic education with respect to the values and aspirations of parents in rural African communities. (p. 128)

Looking at this war from a historical perspective, we can once again note that school, at its outset, was superimposed on African village life and that, therefore, its valued type of intelligence, deleting the social component, is a more recent phenomenon.

Signs That Wealth and Education Shift the Definition of Intelligence Away from Social Qualities

Grigorenko and colleagues (2001) provide evidence for this thesis. They found that intelligence for Luo living in an agricultural village in Western Kenya was defined in terms of two main components: smartness or knowledge (*rieko*) and social qualities such as respect and care for others, obedience, and diligence (*luoro*). Rieko was considered positive only if luoro was also present, so social goals were dominant in the definition of intelligence. (The primacy of social intelligence is shown on the left side of the Cultural Value rectangle, Figure 38.2.) Without luoro, it was considered that a child could use their rieko for selfish reasons and even against the interests of others. However, there were hints in the qualitative component of the study that education and wealth, two attributes of a Gesellschaft environment, were shifting the defining attributes of intelligence in the cognitive direction and away from the social: The only two participants ranking cognitive rieko higher than social luoro were outsiders to the local community who, unlike the villagers, had attained postsecondary education and were also much wealthier than the villagers. Looking at the situation from a historical perspective, both postsecondary education and wealth were introduced later in time; the Luo's original ecology featured informal education at home and in the community along with a subsistence economy. (These sociodemographic shifts are diagrammed in the top rectangle; the shift to technological intelligence as primary is diagrammed in the Cultural Value Change rectangle; and the two levels are linked with a vertical causal arrow, Figure 38.2.)

A second study (Sternberg et al., 2001) explored the relationship between highly adaptive and contextualized knowledge in the same rural Luo village and tests of academic intelligence. The domain of adaptive knowledge was herbal medicines used to fight illness, necessary in an environment in which most children had parasitic infections at any one point in time. Scores on the test of knowledge of parasites were negatively correlated with all tests of academic intelligence. Hence, they are on opposite sides of the Individual Development rectangle (Figure 38.2). Wealth also had a significant negative correlation with the knowledge of herbal medicines. Again, given that schooling and wealth were overlaid on a culture that already had knowledge of herbal medicine, we can infer that the influence of schooling and wealth will continue to reduce detailed practical knowledge of herbal medicines. Indeed, World Bank (2018a, 2018b) data indicate that both educational opportunity and wealth are continuing to rise in Kenya. These two sociodemographic shifts are shown in the top rectangle of Figure 38.2. A vertical arrow shows the hypothesized causal relationship between these shifts and the shift from knowledge of herbal remedies to academic intelligence in the bottom rectangle.

Crystallized Intelligence: The Case of Know and Na'

Crystallized intelligence is the ability to use skills, knowledge, and experience (Cattell, 1941). Knowledge is therefore a component of intelligence measurement; it is at the heart of the contrast between *know* and *na'*, the Tzotzil word for "know" in the Maya community of Mitontik in Chiapas Mexico (Zambrano & Greenfield, 2004).

> Although na' clearly glosses as 'know' (Laughlin, 1975), and even overlaps with it, its core meanings are surprisingly different. Na is much more demanding in key respects, such as in its reference to practice. However, in a world in which cultures have been in close contact – through involuntary processes such as conquest, voluntary processes such as immigration, and systemic processes such as economic globalization – different ethnoepistemologies can also come into contact. And this is exactly what has happened to na' and know in the Tzotzil-speaking community of Mitontik. Na' . . . epitomizes indigenous values concerning knowledge, whereas know is highly valued in the school, an institution that has been imposed on Maya communities from outside . . . Whereas to 'know' in English always involves the mind, na' often involves the heart and soul . . . Whereas 'knowing' connotes factual knowledge, theoretical understanding, or know-how, na' also connotes knowledge of practice that is habitual and characteristic of a given person; it is very much akin to character. The former type of knowledge is more important in a culture placing a value on social character. Both forms of knowledge coexist in San Miguel Mitontik; however, na', a Tzotzil word, originates in the indigenous Maya culture and is traditionally valued at home. 'Know' (or saber in Spanish) originates in the school, imposed on Mayan communities by the Spanish-speaking Mexican state, the institutional inheritance of the Spanish conquest. (Zambrano & Greenfield, 2004, pp. 252–253)

Na' is therefore historically more recent.

The word "know" is what the fields of intelligence testing and cognitive psychology care about: the solving of a novel problem once. The word *na'* requires that a problem be solved habitually and repeatedly implemented. "The concept of *na* . . . embraces a broader conception of knowledge (and thus intelligence) that presses us to admit that the academic world produces but a small amount of the knowledge and intelligence in the world" (Zambrano & Greenfield, 2004, pp. 268–269). The historical shift from *na'* to "know" with formal education is diagrammed in the Sociodemographic and Cultural Value rectangles (Figure 38.2), with a vertical arrow representing their causal link.

Historical Change in Cultural Tools: Implications for the Raven's, a Test of Fluid Intelligence

I now move from crystallized to fluid intelligence and an analysis of the connection between social change and the Raven's Progressive Matrices test. I again start with Nabenchauk, the Zinacantec Maya community in Chiapas, Mexico. As noted in the section "From Tradition and Task-Relevant Detail to Innovation and Abstract Representation," over a period of two decades, Nabenchauk shifted from an agrarian, subsistence ecology, where almost all education took place at home and in the community, to a commercial ecology in which schools became increasingly important. The IQ test, the Raven's Progressive Matrices, depends on understanding the structure of a matrix; this is cultural knowledge (Greenfield, 1998). To solve matrix problems, such as those presented on the Raven's, one needs to understand that a matrix is organized in rows and columns. One must also understand that there is an ordinal relationship among the columns and rows, as well as what mental operations are relevant to perform on the test matrix. All of this is culture-specific knowledge; there is nothing in the matrix figures themselves that specifies what mental operations to perform.

As a subsistence community whose residents did not read and write their spoken language of Tzotzil, Nabenchauk had no matrices in its environment. Matrices in the form of cross-stitch patterns for embroidery laid out on graph paper were introduced into the agrarian community by school teachers. Clearly the skills measured by the Raven's could not have been part of the definition of intelligence in Nabenchauk before any matrices existed in the environment. Our research indicated an association between the use of these patterns and schooling: Zinacantec women who had a few years of schooling were more likely to use these patterns for embroidery or weaving than women who had never been to school (Maynard & Greenfield, 2008). These patterns are a very simple form of matrix; unlike the Raven's, they do not involve any ordinal relationship among columns or rows. However, they form a foundation that could serve as a basis for understanding ordered matrices and for defining intelligence in terms of the mental manipulation of matrices – that is, the use of the Raven's as a measure of intelligence.

Fast forward to the United States and other countries with widespread and highly developed computer technologies. As part and parcel of the technology, the use of matrices has become increasingly diffused in the population. An example is the popular spreadsheet program Microsoft Excel; Excel provides blank matrices, organized in columns and rows, to be filled in by the user. “Clearly, such a program requires users to represent their data mentally in matrix form, while providing practice in the use of this representational format” (Greenfield, 1998, p. 110).

Thus, it has become increasingly relevant to US culture to utilize the Raven’s as an intelligence measure; this increasing relevance could have produced a part of the Flynn effect, the historical increase in IQ scores that shows up in the historical increase in the Raven’s (for more about the Flynn effect, see Flynn, Chapter 39 in this volume). As a hypothetical, one can imagine that, as formal education and computers continue to develop in Nabenchauk and other Zinacantec communities, trends that are currently taking place (Manago & Pacheco, 2019; Maynard et al., 2015), manipulation of matrices could come to be one measure of intelligence in the Nabenchauk of the future, as well as in other communities around the world in which the expansion of formal education and diffusion of computer technologies are moving environments ever more in the Gesellschaft direction. There is a close relationship between a culture’s technologies and its definition of intelligence (Maynard, Subrahmanyam, & Greenfield, 2005). Hence, as technology develops, we can expect parallel developments in the definition of intelligence, specifically a link between computer technology (top right side of the Sociodemographic rectangle) and this test of fluid intelligence (right side of Cultural Value rectangle). (This causal connection is depicted by the vertical arrow linking the Sociodemographic rectangle with the Cultural Value rectangle, Figure 38.2.)

Historical Change in How Intelligence Is Defined in a Leading IQ Test

Intelligence in our society has often been defined as “what the tests measure.” Apart from academic dissections of the nature of intelligence, we can make a case that popular intelligence tests measure what the society thinks is important. It is therefore instructive to look at how the most venerable children’s intelligence test, the WISC or Wechsler Intelligence Scale for Children, has been changing over recent decades. We will see that, even in our society, Gesellschaft factors are moving our functional definition of intelligence in the direction of decreasing emphasis on social understanding, decreasing emphasis on detailed knowledge, increasing emphasis on abstraction, and increasing emphasis on dealing with novelty.

In line with the tenet of the theory of social change and human development – that the sociodemographic factor changing most rapidly in a community or society will drive changing patterns of human development – technology (top level of Figure 38.2) has created new patterns of cognitive development, strengthening skills that are important in adapting to the spread and enhancement of technologically mediated communication (Greenfield, 1993, 2009a). For example, media such as video games have developed visuospatial skills; and communication has become more abstract (in the sense of removed from the physical world) because of its virtuality (Greenfield, 2019). I am going to make the case that these changes in cognitive skills have also affected our measurement and therefore our societal definition of intelligence.

By 2003, the publication date of the WISC-IV, we were clearly in the midst of a technological revolution, and some very revealing changes took place in the test: Picture arrangement, the only subtest that assessed understanding of social situations and social actions, was dropped from the WISC-IV. Mazes and Object Assembly were also dropped; these tests both involved analysis of a present stimulus situation. In the words of Pearson, the publisher of the WISC:

> Compared to the WISC–III, the WISC–IV FSIQ deemphasizes crystallized knowledge . . . and increases the contribution of fluid reasoning (Matrix Reasoning and Picture Concepts) . . . and Processing Speed (both Coding and Symbol Search). (Pearson, 2010)

Here we see that novelty (labeled as fluid reasoning) and speeded cognition are becoming ever more important in the definition of intelligent qualities to be assessed by the tests (diagrammed on right side of the Cultural Value rectangle, Figure 38.2).

In the following Pearson quote, we see the continuation of another historical trend that we found in Nabenchauk. In the substitution of a Picture Concepts subtest for the older Picture Completion subtest, attention to visual detail is being devalued as a lower-order cognitive ability in comparison with fluid reasoning:

> Picture Completion and other, more traditional measures of perceptual ability, measure visual discrimination and attention to visual detail, which is a lower order cognitive ability than fluid reasoning. (Pearson, 2010)

In other words, in the latest edition of the WISC, understanding of social situations is eliminated as part of assessing intelligence; understanding concrete here-and-now situations is deemphasized; attention to visual detail is considered a lower form of intelligence; while the manipulation of abstractions and processing speed are given greater emphasis. Shifts in defining intelligence that were originally noted when schooling was introduced into Africa have continued and intensified in the United States (Cultural Value level, Figure 38.2).

Recall that, over time, in Zinacantec Maya children's approach to representing woven patterns, the attention to detail required for constructing the woven patterns, gave way to abstract representations that would be useless in creating the patterned cloth. That historical trend was fueled by the development of commerce and formal education (Maynard et al., 2015). These factors are now constants in our US ecology of the last forty years (Huang et al., in prep.); instead, the major change in our ecology is technology. My hypothesis is that technological development and diffusion are now moving our definition of intelligence ever further in the direction of novel and abstract cognition. Indeed, fluid intelligence is defined as the capacity to reason and solve novel problems, independent of any knowledge from the past. It is the ability to analyze novel problems, identify patterns and relationships that underpin these problems, and the extrapolation of these using logic. So an increasing emphasis on fluid intelligence in defining the construct in tested intelligence equates to an increasing emphasis on innovative thought and "going beyond the information given" (Bruner, Goodnow, & Austin, 1956). This is exactly the historical trend we saw in the Zinacantec hamlet of Nabenchauk with the growing pattern and other novel patterns, there fueled by the growth of commerce and formal education. This is an example of the equipotentiality of Gesellschaft features (right side of the Sociodemographic rectangle, Figure 38.2).

The fifth edition of the Wechsler Intelligence Scale for Children, WISC-V, has a new Visual-Spatial Index, which measures a child's ability to reason in nonverbal tasks such as rotating and organizing shapes. These are exactly the skills developed by action video games (Greenfield, 1998). The changes also reflect other cognitive changes that are adaptations to the new technologies: As representation becomes more iconic and less symbolic (Greenfield et al., 1994), Picture Span (short-term memory for visual images) has supplemented Digit Span (short-term memory for numerals). The growing cultural importance of iconic representation is portrayed on the right side of the Cultural Value rectangle, Figure 38.2).

Conclusions

In sum, the history of the nature of intelligence has a globalized direction of change under the influence of the sociodemographic changes shown in Figure 38.2: Ever more technology, urbanization, formal education, wealth, and commercialized economies. The direction of change in valued intelligence, summarized in Figure 38.2, is from the integration of social responsibility, wisdom, and spirituality with cognitive intelligence toward purely cognitive skills; from practical, detailed, and contextualized to abstract, decontextualized cognition; from slow and careful thinking to speeded cognition; from repetition of the known to extrapolation and novelty; from habitual practice to innovation; and, using the language of IQ tests, from crystallized to fluid intelligence.

However, as Sternberg and Grigorenko (2000) have emphasized, practical context-specific intelligence based on tacit knowledge continues to exist alongside more abstract intelligence, even in the United States – for example, Jean Lave and colleagues' work on calculations made while shopping in grocery stores (Lave, Murtaugh, & de la Rocha, 1984) and Silvia Scribner's (1984) research on calculations made by dairy workers. Each setting and function stimulated the development of a specific arithmetic technique that was neither generalizable nor taught in school. In the domain of social intelligence, social responsibility and respect as *desiderata* continue to be important qualities to groups within the United States that are relatively poor and have lacked opportunity for formal education (Greenfield & Quiroz, 2013; Vasquez-Salgado, Greenfield, & Burgos-Cienfuegos, 2014). Social and practical intelligence are basic qualities that were adaptive in human beings' evolutionary ecology. Wisdom is desperately needed to solve today's societal problems (Sternberg, 2018). These qualities are critical to the human condition. However, so long as human technology, wealth, urbanization, commerce, and education continue to expand, these characteristics of human intelligence are in grave danger of receiving ever less respect and development as the future unfolds.

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