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CONTINUING EDUCATION

Evolution of Self-Awareness and the Cultural Emergence of Academic and Non-academic Self-Concepts

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Abstract

Schooling is ubiquitous in the modern world and academic development is now a critical aspect of preparation for adulthood. A step back in time to pre-modern societies and an examination of life in remaining traditional societies today reveals that universal formal schooling is an historically recent phenomenon. This evolutionary and historical recency has profound implications for understanding academic development, including how instructional practices modify evolved or biological primary abilities (e.g., spoken language) to create evolutionarily novel or biologically secondary academic competencies (e.g., reading). We propose the development of secondary abilities promotes the emergence of academic self-concepts that in turn are supported by evolved systems for self-awareness and self-knowledge. Unlike some forms of self-knowledge (e.g., relative physical abilities) that appear to be universal and central to many people's overall self-concept, the relative importance of academic self-concepts are expected to be dependent on explicit social and cultural supports for their valuation. These culturally contingent self-concepts are contrasted with universal social and physical self-concepts, with implications for understanding variation students' relative valuation of academic competencies and their motivations to engage in academic learning.

Keywords Self-awareness · Academic self-concept · Evolution · Secondary learning · Achievement

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Introduction

Successfully navigating life in the modern world requires the development of core academic competencies (Richmond-Rakerd et al., 2020; Ritchie & Bates, 2013) and thus it is not surprising that complex educational systems have emerged and grown in these nations (Goldin, 1999; Ramirez & Boli, 1987). At this point in history, it likely seems natural for children and adolescents to attend school and for scientists and educators to study the factors that contribute to academic success. Indeed, much is now known about the cognitive and noncognitive traits that contribute to academic development. As an example, the myriad factors that influence mathematical development include attitudes and beliefs about one's mathematical competence and the long-term utility of mathematics (Eccles & Wigfield, 2002; Lauermann et al., 2017), mathematics anxiety (Dowker et al., 2016), as well as domain-general cognitive abilities (e.g., working memory; Geary et al., 2017; K. Lee & Bull, 2016), specific cognitive abilities (e.g., spatial; Geary et al., 2021; Mix & Cheng, 2012), and in-class attention (Fuchs et al., 2006).

A broader cross-cultural and evolutionary perspective, however, indicates that schools are evolutionarily novel and most of the school-related activities and associated beliefs are far from natural for children (Lancy, 2016). In traditional contexts, children and adolescents engage in activities that will prepare them for adult activities in these contexts, but the associated competencies emerge from a combination of evolved cognitive abilities and biases that are elaborated through engagement in species-typical developmental activities and observational learning and imitation of adults (Lancy, 2016). The knowledge learned in this way tends to be instrumental, focused on a culturally important outcome (e.g., hunting, foraging), and does not include academic competencies (Legare, 2017). This contrasts with modern schooling that involves organizing children's activities so they can acquire competencies that do not emerge in traditional contexts (e.g., reading, mathematics) but are critical for success in modern economies. Based on the ways children learn to speak their native language or to interact in social situations, some scholars continue to argue that the activities that are common in traditional contexts (e.g., child-initiated play, imitation) are sufficient for academic learning (Gray, 2016), even though studies of both reading and mathematics learning indicate that this is not the case (National Institutes of Health, 2000; National Mathematics Advisory Panel, 2008).

Geary (1994, 1995) proposed that universal cognitive abilities are biologically primary (below) and those that only emerge with organized schooling are biologically secondary. The latter are built from school-related instructional activities that result in the modification and reorganization of biologically primary systems, such as coopting aspects of the language and basic visual systems for learning how to read. The potential ways in which secondary abilities can be built from primary systems (Geary, 2007, 2008, 2022; Geary & Berch, 2016) and associated instructional implications (Sweller, 2021; Sweller et al., 2019) are discussed elsewhere. The goal here is to consider students' academic self-concepts and self-evaluations from an evolutionary perspective, and to integrate them into what is known about the evolution and development of self-awareness.

In accordance with the distinction between biologically primary and secondary abilities, we propose there are universal aspects of peoples' self-concepts that are formed around many primary abilities (e.g., related to social competencies) and other traits (e.g., physical abilities) associated with survival and reproductive activities in traditional contexts. Self-concepts and self-evaluations also emerge for secondary abilities and culture-specific traits and activities, including academic self-concepts, but these may require more social (e.g., parental valuation) and cultural supports (e.g., highlighting the accomplishments of successful people in these domains) for their development than universal dimensions of peoples' self-concept. Even in cultures where specific traits are emphasized (e.g., competence at specific survival-related tasks), self-concepts in these areas might be less critical to ones' overall self-concept or self-esteem than are universal traits. In other words, we argue that self-concepts in more universal domains of life (e.g., building social relationships) are more important to the overall self-concept than those in biologically secondary academic domains.

We begin with an introduction to primary folk abilities that includes a review of the evolution and development of self-awareness and self-concepts. To place secondary abilities and associated academic self-concepts in perspective, we then provide a brief review of the cultural history of educational systems. Lastly, we close with a discussion of empirical studies of academic self-concepts and motivations in developed nations, as related to our evolutionary approach.

Primary Abilities and the Evolution of Self-Awareness

One way to conceptualize primary abilities is in terms of folk psychology, folk biology, and folk physics (Atran, 1998; Geary, 2005; S. Gelman, 2003; Leslie et al., 2004; Mithen, 1996; Wellman, 2017; Wellman & Gelman, 1992). The core folk areas and knowledge bases are shown in Fig. 1. The social level reflects the evolutionary salience of other people and their behavior (Brothers and Ring, 1992; Flinn et al., 2005; Humphrey, 1976), and competencies at the ecological level (the biological and physical ecologies) support survival and reproductive activities in traditional contexts (Kaplan et al., 2000). The third level represents functional systems that compose key folk domains, that is, different combinations of abilities and knowledge can be put together in building-block form to meet current social or ecological demands (Geary, 2005). As an example, the 'individual' level under folk psychology captures the abilities (e.g., language, face processing) and knowledge (person schema) that are engaged during social interactions with other people and that support the development and maintenance of social relationships.

These domains can be considered modular in that they represent coherent abilities and knowledge schemas, but there is not a one-to-one correspondence between them and a single region in the brain. Language, for instance, is a coherent and very functional social-cognitive ability but is supported by a system of regions that are distributed across various areas in the brain (Gernsbacher & Kaschak, 2003) and is highly integrated with other social competencies, such as use of gesture (Skipper et al., 2007). In general, folk abilities represent brain, perceptual, and cognitive

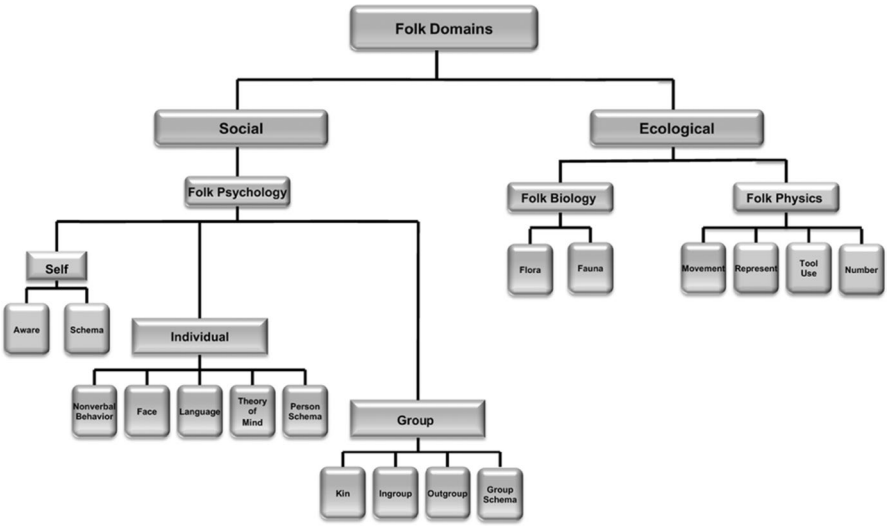

Fig. 1 Primary folk abilities coalesce around the domains of folk psychology, folk biology, and folk physics. These enable the navigation of core social relationships and the common ecological demands (e.g., hunting) of people living in traditional contexts. Adapted from "*The origin of mind: Evolution of brain, cognition, and general intelligence*," by D. G. Geary, 2005, p. 129. Copyright 2005 by American Psychological Association

systems that enable people to develop and manage social relationships, forage and hunt, construct tools, and remember and navigate in the local ecology. Here we focus on one aspect of folk psychology, that is, the self-system. We aim to provide a brief review of comparative and evolutionary studies of self-awareness and self-knowledge and consideration of which aspects of this knowledge are most relevant to our understanding of academic self-concepts.

Self-Awareness and Knowledge

Self-awareness is the "ability to take oneself as the object of attention and thought" (Leary & Buttermore, 2003, p. 366) and self-schema is knowledge that contributes to a social identity (e.g., kin relationships), as well as self-knowledge related to traits that are socially and ecologically important in the contexts in which the individual resides. In the following, we briefly discuss different aspects of self-awareness and self-knowledge, their evolution and supporting brain systems, and the framing of cultural influences on individuals' domain specific self-concepts within an evolutionary perspective. The evolutionary approach supports inferences about aspects of the self that are likely to be universally important and thus central to most peoples' sense of self and their self-esteem, such as social relationship or physical appearance self-concepts.

These can be compared to traits that are important in some but not all social and cultural contexts and thus may be more dependent on social supports for their

development and less central to many peoples' self-concept, even in contexts in which the traits are important. For instance, we predict that physical self-concepts (e.g., attractiveness, athletic ability) will be universally important aspects of the self-schema, but academic self-concepts will be more variable (i.e., important for some students but heavily discounted by others) even in contexts where academic competencies are related to success in adulthood. We argue that the latter primarily include self-concepts related to biologically secondary academic domains, such as mathematics.

Different Selves

Neisser (1988) proposed there are five forms of self-knowledge. The first two are *ecological* and *interpersonal* and involve organized responses to ecological and social conditions that imply at least an implicit understanding of the distinction between the self and other things. These do not involve an explicit reflection on the self and ecological and social interactions, just coherent self-interested and species-typical responses to these contexts, as illustrated by the synchrony of mother-infant interactions (Bernieri et al., 1988). The *private self* is a conscious experience of and ability to remember events that are only available to the self, such as a dream (Neisser, 1988). The private self supports the ability to convey internal states (e.g., hunger, loneliness) to others, and may have been part of the foundation that resulted in the evolution of theory of mind, that is, the ability to infer the thoughts and feelings of others (Gallup, 1998).

The *extended self* and the *conceptual self* are the most highly developed in humans relative to other species (Leary & Buttermore, 2003), and critical for understanding the development of academic self-concepts. The extended self involves an awareness that the self continues across time and integrates past, present, and potential future representations of oneself. The ability to imagine a future self enables the simulation of desirable future states and the development of strategies to help bring them about (Geary, 2005). An understanding of a potential future self will also be critical for academic outcomes, including an awareness of how ones' academic strengths will be useful for further educational and occupational opportunities (Eccles & Wigfield, 2002). The conceptual self is composed of more abstract and generalized representations of features of the self, such as social identity (e.g., as a spouse, student), personality (e.g., introverted or extraverted), and common ways of responding (e.g., punctual). Academic self-concepts are part of the conceptual self and an important component of peoples' self-knowledge in societies with formal schooling and modern economies.

Brain System and Evolution

Gallup's (1970) finding that at least some chimpanzees (*Pan troglodytes*) recognize themselves in a mirror, implying some level of self-awareness, jump started scientific debate and comparative studies of self-awareness (Povinelli, 1993; Povinelli et al., 1993), a debate that continues to this day (Gallup & Anderson, 2020; Morin,

2021). Subsequent studies suggest that self-recognition is typically found in studies of great apes and maybe a few other species (Baciadonna et al., 2021; Kohda et al., 2019; Reiss & Marino, 2001), although the extent of the latter is vigorously debated (de Waal, 2019; Gallup & Anderson, 2020). As shown in Fig. 2, de Waal notes two perspectives on the evolution of self-awareness and passage of the mirror self-recognition (MSR) test. A common perspective is the great leap forward (Fig. 2A), whereby self-awareness rapidly emerged in the evolution of a few species (e.g., great apes). The gradualist approach (Fig. 2B) is consistent with Neisser's (1988) different forms of self-awareness. In this view, the ecological and interpersonal self are common across species and the foundation for the emergence of forms of self-awareness that involve an explicit evaluation of specific aspects of the self (e.g., relative physical abilities).

For hominins (ancestors of modern humans), Leary and Buttermore (2003) argued that the extended self emerged with *Homo habilis* about 2 million years ago, as evidenced by their construction and transport of tools across locations. The latter suggests some forethought and planning and is not found in chimpanzees and thus not likely to have existed in the ancestor common to chimpanzees and humans. It is more difficult to make inferences about the evolutionary emergence of the private self, but this might have initially emerged with *Homo ergaster/erectus* (which evolved about 1.8 million years ago; Carotenuto et al., 2016) and was driven by increases in group size in this species. Leary and Buttermore proposed that a conceptual self might not have emerged until the evolution of modern humans. The evidence for this is found in the emergence of art, music, body adornments (including status-related adornments), and other symbols that date back about 40,000 years. From this perspective, the conceptual self is uniquely human and when combined with an elaborated extended self (i.e., the ability to think of oneself in the distant

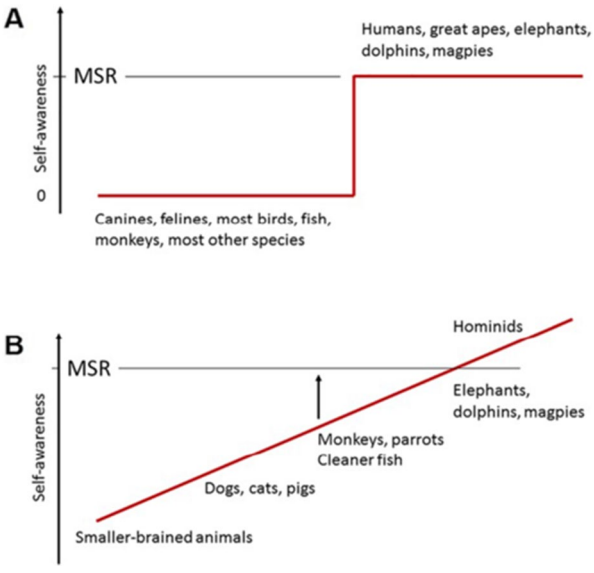

Fig. 2 Discontinuous (**A**) and continuous (**B**) evolution of self-awareness as indicated by the mirror self-recognition (MSR) test. From de Waal FBM (2019) Fish, mirrors, and a gradualist perspective on self-awareness. *PLoS Biology 17(2)*: e3000112. https://doi.org/10.1371/journal.pbio.3000112. Creative Commons License

future) provides the evolutionary foundation for symbolic culture (e.g., art, writing). In other words, the ability to represent the self abstractly (e.g., as a good hunter) co-evolved with the ability to generate other types of abstract symbols, such as dress or jewelry that signal social identity and status, and eventually abstract scientific concepts, such as gravity, among other advances.

Neuroscience and cognitive research provides further evidence about the selection pressures that drove the emergence of the extended and conceptual self. In keeping with Neisser's (1988) extended self, peoples' self-awareness appears to be integrated and may have co-evolved with the ability to mentally time travel (Suddendorf & Corballis, 2007; Tulving, 2002), that is, the ability to generate self-centered simulations of past, current, and potential future states. This ability is supported in part by the brain's default mode network and top-down executive processes that act on autobiographical (personal) memories and other representations of the self (Lou et al., 2017; Raichle, 2015). The precuneus (in the parietal lobe) is one area of the default mode network and is involved in feelings of agency, self-awareness, personal memories, and thinking about the world in self-relevant ways (Cavanna & Trimble, 2006; Rugg & Vilberg, 2013), whereas areas in the prefrontal cortex are important during conscious reflections about the self, including explicit self-evaluations (Davey et al., 2016).

The combination of the default mode and executive attention networks enables people to generate a conscious representation of themselves in the context of past and potential future social scenarios, among other contexts (Andrews-Hanna et al., 2014) and to engage in social comparisons and to socially strategize (Geary, 2005; LeDoux & Brown, 2017; Raichle, 2015). The content of these thoughts provides important clues regarding its evolutionary function:

The content of self-generated thoughts suggests that they serve an adaptive purpose by allowing individuals to prepare for upcoming events, form a sense of self-identity and continuity across time, and navigate the social world. On average, adults tend to rate their thoughts as goal oriented and personally significant, yet thoughts also commonly involve other people. (Andrews-Hanna et al., 2014, p. 32).

The self-schema, as noted, is composed of a long-term memory network that links autobiographical memories with knowledge and beliefs about the conceptual self. These beliefs often involve accentuated self-evaluations of one's socially or culturally positive traits (e.g., friendliness) and the discounting of negative ones (e.g., antagonistic), as well as personal evaluations of competence or self-efficacy in various areas (Bandura, 2001; Fiske & Taylor, 1991; Ryan & Deci, 2000). Based on the thoughts associated with activation of the default mode network, the self-schema and conceptual self should be organized, at least in part, in terms of key social relationships, especially kinship (e.g., family, parents), same-sex social support network (i.e., peer relationships, friends), and actual or potential opposite-sex relationships.

Although they were not guided by an evolutionary framework, studies of people's self-concepts consistently identity these social relationships as a core part of the self-schema or conceptual self (Esnaola et al., 2020; Harter, 2006; Rentzsch et al., 2016; Shavelson et al., 1976). These studies also identified physical abilities and physical appearance as important components of self-concept, which also follows from an evolutionary perspective. This is because physical abilities are important

for survival (e.g., hunting) and reproductive competition in traditional contexts, especially for men, whereas physical appearance influences mate choices and general social treatment (Geary, 2021). The importance of these social relationships and physical traits for the development of ones' self-concept and general self-esteem is likely a human universal and contributes to pride or self-esteem (Durkee et al., 2019).

Even so, physical abilities and social relationships contribute to survival and reproductive prospects in many species, most of which do not have a highly developed extended and conceptual self (e.g., canids; Barber-Meyer & Schmidt, 2020). The selection pressures that drove the elaboration of these and other cognitive abilities during human evolution are debated and include the ability to anticipate and prepare for variation in seasonal changes (e.g., winter, Kanazawa, 2008; Potts, 1998), the protracted learning needed to become proficient in obtaining the staples of life (e.g., hunting; Kaplan et al., 2000), and competition with other people or groups of people (Alexander, 1989; Flinn et al., 2005; Geary, 2005). Given the content of the thoughts generated by the default mode network, social competition is almost certainly an important part of these selection pressures but preparing for seasonal changes and planning hunts are also plausible contributors to the evolution of the extended self.

Whatever the mix of selection pressures, the evolutionary advantages of an extended self and the ability to generate mental simulations of potential future states include the ability to plan (e.g., bring tools to a forage site; Leary & Buttermore, 2003) and to generate and rehearse various strategies for bringing about desired outcomes (Geary, 2005). In other words, people can think about themselves at some future time, and this representation can be compared to a mental representation of one's current situation. In this future state, people typically have enhanced social status, influence, and access to culturally important resources relative to their current condition. This future state is a goal to be achieved and explicit social strategizing and problem solving enable people to plan ways to reduce the difference between where they are today and where they want to be in the future. These mental simulations reduce dependence on trial-and-error learning and create a mechanism for generating novel solutions to recurrent problems.

The advantages of a conceptual self are less evident but might be particularly important in complex symbolic cultures. The emergence of these cultures was associated with a blossoming in the production of various artifacts related to art, music, personal adornments, weapons, and so forth (Leary & Buttermore, 2003). Some of the personal adornments (e.g., found in burial sites) are consistent with symbolic status symbols, in keeping with a social component to the evolution and functioning of the conceptual self. The variation in artifact production also suggests potential expansion in cultural niches, with different individuals potentially specializing in the creation of different types of artifacts. Such an expansion would favor an awareness of ones' relative strengths and weaknesses, strengths relative to others (assessed through social comparisons), and an understanding of the social and cultural importance of different outcomes.

The ability to develop differentiated self-representations would then be beneficial in terms of seeking niches that are socially and culturally important and that allow

one to focus on ones' strengths. The initial differentiation was, however, likely constrained by social and ecological factors that limit the expression of individual differences, as is seen in traditional contexts today relative to developed nations (e.g., Bailey et al., 2013; Gurven et al., 2013). It is possible that the ability to form a conceptual sense evolved with the emergence of symbolic culture and we are only now seeing its full expression in modern societies or that it has continued to co-evolve with the expansions of social and economic niches with the emergence of large-scale societies. Either way, the associated conceptual self provides the foundation for academic self-concepts.

Self in Cultural Context

An evolutionary perspective also leaves room for cross-cultural variation in the relative importance of different traits for ones' self-concept. The bases of the link are provided by Barkow's (1975) and Henrich and Gil-White's (2001) prestige and Irons' (1979) cultural success. The latter represents the ways in which the evolved desire for status and social influence can be achieved in the current ecology and social group and can be influenced by cultural history. In some traditional contexts, success is contingent on having a large herd of cattle or plot of arable land, whereas in developed nations it is more strongly influenced by educational and occupational outcomes. Prestige is based on the acquisition of culturally important competencies (e.g., hunting skills and returns) that when expressed can contribute to the well-being of others who then freely confer status and influence on the individual with these competencies (Anderson et al., 2015). In addition to hunting, ethnographies indicate that prestige and self-esteem are related to success in other ecologically important endeavors including farming skills in horticulturalists, animal husbandry in pastoralists, and fighting competencies in groups in conflict (Barkow, 1975). Generosity, food sharing, and other behaviors that promote social cooperation and reduce conflict are also important sources of prestige and self-esteem in traditional contexts (e.g., Barkow, 1975; Mayor, 2012; Peterson, 1997).

Expanding on the concepts of prestige and cultural success, Winegard et al. (2020) proposed the coalitional value theory, whereby people are aware of and track their own competencies and those of others, as is well documented (Festinger, 1954; Gerber et al., 2018), and specifically do so with respect to the added value of these competencies in the context of the relationships and groups in which they are embedded. For instance, a successful hunter adds value to the overall well-being of the group (as the proceeds are shared) and these individuals typically have higher status and social influence (i.e., higher prestige) than their less apt peers (Smith, 2004). People are aware of the relative hunting abilities of different individuals, because successful hunts often result in social displays that convey information about who is a skilled hunter (Trumble et al., 2014). Self-knowledge of ones' relative hunting abilities likely influences self-esteem in these contexts and this knowledge would allow successful hunters to better pursue their interests (Barkow, 1975).

The perspective here is consistent with Leary and Baumeister's (2000) sociometer theory of self-esteem. The latter is a social barometer that reflects the

contributions of ones' attributes and behaviors to the well-being of others and this in turn reflects ones' social value and belongingness. In other words, people are aware of socially valued traits and outcomes and may be biased to invest in the development of these attributes, as this increases self-esteem. The motivation to maintain or achieve self-esteem in turn prompts investment in the development of socially valued traits. In this situation, awareness of ones' relative strengths enables strategic investment in these areas and in doing so would result in advantages over individuals who were less self-aware.

Universally valued attributes, such as physical attractiveness, should contribute to self-esteem, but so should the development of evolutionarily novel abilities if they are culturally valued or contribute to culturally valued outcomes. Indeed, Freeland and Hoey (2018) found that many high-status occupations (e.g., physicians, nurses) in developed nations "involve a common orientation toward providing service to society' (p. 256), in keeping with the cross-cultural importance of generosity and helping others as components of prestige (Barkow, 1975), although social power (e.g., judges) and professional knowledge are also important contributors to occupational status. People's identification and satisfaction with their job is influenced by the social prestige afforded to individuals in that occupation, above and beyond their income, in keeping with a social valuation component to occupational choices.

In any case, the point here is that the conceptual- and extended-self should be particularly important in highly complex societies with myriad social and economic niches, because success in these societies requires, in part, the development of evolutionarily novel academic abilities that oftentimes involves a long-term educational investment. At the same time, the associated academic self-concepts and the valuation of gaining competence in these domains may contribute less to students' overall global self-concept or self-esteem than social or physical attributes (elaborated in "Academic Self-Concepts" section), given the evolutionary novelty of academic abilities. This novelty may result in weaker engagement of inherent reward systems than advantages in physical and social activities. So, winning a sports competition or engaging with friends is likely to be more inherently rewarding than acing a mathematics exam, even if strong mathematical competencies contribute to long-term success in prestigious occupations.

Indeed, many elementary-school children value sports over academic achievement (Eccles et al., 1993). Adolescents rate social relationships as more important than academic competencies (Eccles et al., 1989) and report that in-school activities are a significant source of negative affect (Larson & Asmussen, 1991). For a nationally (USA) representative sample, Csikszentmihalyi and Hunter (2003) found that the lowest levels of happiness were experienced by children and adolescents while they were doing homework, listening to lectures, and doing mathematics, and the highest levels when socializing with friends (see also Larson & Richards, 1998). This is not to say that academic self-concepts do not contribute to self-esteem but rather that they are not likely to be as universally valued as concepts related to social relationships and physical traits and thus are more likely to be dependent on social and cultural supports for their development, as described next.

Development of Self-awareness

Children's developing sense of self should be primarily integrated with their *social* development from an evolutionary perspective and based on the content of the thoughts generated by the default mode network (Andrews-Hanna et al., 2014) and the centrality of social relationships to peoples' self-concept (Shavelson et al., 1976). And this is the case (Rochat, 2003, 2021). By 3 years, children become more sensitive to the potential evaluations of others and may change their social presentations to elicit more positive evaluations (K. Lee, 2013), conform to the beliefs of others (Haun & Tomasello, 2011), and strategically conform when it is in their best interest (Cordonier et al., 2018). These all reflect developmental change in sensitivity to oneself, the current social context, and to the social evaluations of others, as well as the balancing of self-interested behaviors versus cooperative behaviors to maintain social relationships (Rochat, 2021).

The developmental emergence of self-awareness is interwoven with children's ability to use the episodic memory system to mentally time travel (episodic foresight), that is, to imagine themselves in a future situation (Suddendorf & Redshaw, 2013). Children have some components of episodic foresight by about 4 years, and by 5 years they can begin to generate and judge alternative future scenarios. During this same time, children are developing the ability to understand other peoples' future states, which is important for coordinating reciprocal future activities and is necessary for developing and maintaining friendships (Kumaki et al., 2018; Payne et al., 2015). Their competencies in these areas, including their appreciation of the time scales on which future events could occur and their ability to enact planned goals, continues to develop through the elementary school years. (Suddendorf, 2011).

These patterns suggest that self-awareness and self-concepts co-evolved with mental time travel and support the development and maintenance of social relationships. The ability to integrate non-social and non-physical traits, including academic competencies, into a conceptual self is almost certainly a later-evolving feature of this system and supported by the emergence of and is contingent on a symbolic culture, as described earlier (Leary & Buttermore, 2003). The evolutionary recency and cultural dependence of academic self-concepts leads to the prediction that they will require more social and cultural supports for their development and positive valuation than will social and physical self-concepts.

An example comes from international comparisons of students' mathematical development. Many factors contribute to these national differences, including the rigor of the mathematics curriculum and variation in broader cultural and parental supports that foster mathematics learning (Stevenson & Stigler, 1992). Stevenson and colleagues' comparisons of the mathematics achievement of students from the USA, Japan, and Taiwan provide an illustration (Stevenson et al., 1986, 1990, 1993). The performance gaps, favoring students from Japan and Taiwan, are related, in part, to differences in parental valuation of and expectations for mathematics achievement, including expectations for significant amounts of time spent on academic learning (in school and with homework). Relative to European Americans, an Asian-American advantage in academic achievement (including mathematics) is

also found and largely related to parental expectations and relative focus on academic achievement (Hsin & Xie, 2014).

However, these educational advantages decline over generations, suggesting cultural assimilation might come with a cost to academic development (Sakamoto et al., 2009). Cultural valuation of academic achievement will make outcomes in these areas more salient and important to children and adolescents and improve academic development, but paradoxically they might not result in more positive academic self-evaluations. This is because of more negative social comparisons with many high-achieving peers and the difficulty of achieving the ideal level of performance.

Cultural Emergence of Formal Education

The developmental emergence of primary abilities, such as language or spatial abilities (e.g., knowing how to navigate from one place to another), largely occurs through an interaction between inherent perceptual, cognitive, and neural systems that provide initial structure to folk abilities and experiences generated through children's engagement in species-typical activities, such as social play, as shown in Fig. 3 (R. Gelman, 1990; Keil, 1992). For this dynamic to occur, engagement in species-typical activities, such as exploration of the ecology (which helps the development of spatial abilities), must be influenced by inherent motivational and affective systems that guide children to seek and repeat some types of experiences more frequently than others (Bjorklund & Pellegrini, 2002; Geary & Bjorklund, 2000; Scarr, 1992). The resulting evolutionarily expectant experiences then adjust the plastic architecture of folk systems (Greenough et al., 1987), adapting them to local social (e.g., the local language) and ecological (e.g., learning to identify hunted species and edible plants) conditions.

The adaptation of folk abilities must be driven by children's self-initiated activities because there is not much direct parental instruction in traditional contexts even

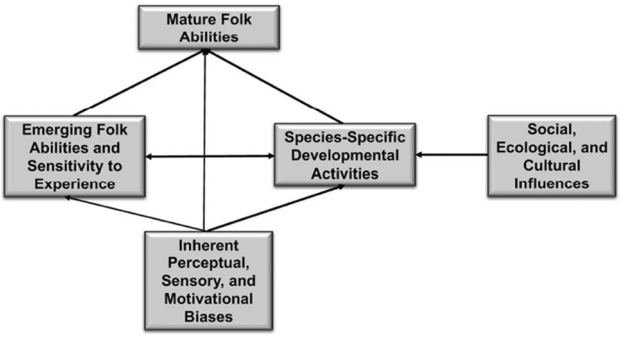

Fig. 3 Inherent biases influence infants' and children's emerging folk abilities and include biases in motivational and reward systems that promote child-initiated species-typical behaviors. These behaviors result in experiences that adapt of folk abilities to local conditions and can be influenced by external factors, including schooling. Adapted from "*Male, female: The evolution of human sex differences*," by D. G. Geary, 2021, p. 302. Copyright 2021 by American Psychological Association

for culturally important tasks, with a few exceptions for some specific tasks (Lancy, 2016). There are oftentimes organized games and play (e.g., use of smaller versions of adult tools) that mirror adult activities, and there is exposure to folk lore and traditions that provide structure to children's learning of culturally important skills and knowledge (e.g., Riede et al., 2018; Scalise Sugiyama et al. 2018). It is thus logical to consider whether these same types of activities can be applied to academic learning in schools. The critical question is whether these child-initiated activities and children's imitation of adult activities are sufficient for academic learning, if children are also given exposure to academic materials (see Gray, 2016). Geary (2007) argued that they are not sufficient, because the emergence of agriculture and larger-scale societies resulted in important changes in the abilities and knowledge needed to be successful in these contexts and that these cultural changes occurred too rapidly to result in the widespread evolution of brain, perceptual, and cognitive biases to facilitate academic learning in the same way they facilitate folk learning.

To put the argument in perspective, many of the folk domains shown in Fig. 1 are universal and very likely already present with the emergence of modern humans about 200,000 years ago (Bae et al., 2017), and certainly fully in place at the time of the emergence of symbolic culture 40,000 years ago. In fact, many of the basic abilities shown in Fig. 1 (e.g., processing social cues, navigation) are evolutionarily conserved, that is, they are found across species and the basic neural and sometimes behavioral architecture for their development has been in place for many tens of millions of years (e.g., Christov-Moore et al., 2014; Trapanese et al., 2019).

In contrast, the type and nature of abilities developed in modern schools are very different from those found in traditional societies and prior to the widespread emergence of universal schooling. This is due to the rapid expansion of the complexity of human societies and the expansion of knowledge needed to be successful in them (e.g., literacy). Formal schooling emerged to ensure the cross-generational transmission of this knowledge in these societies. In other words, formal educational practices only emerged when human societies increased in size and in social and economic complexity relative to that found in traditional cultures. These practices developed (or at least increased in frequency) with the emergence of early empires and date back at least 5000 years (Eskelson, 2020). In these contexts, formal education was focused on training a small number of scribes in literacy and numeracy, who in turn supported the bureaucratic management of these societies. Scribes were relatively high status and likely had more surviving children than the typical citizen of these empires, but there were only a small number of them which would reduce the opportunity for evolution to select for traits that support academic learning.

The complexity of societies increased over time, and schools expanded in the covered academic content and in the student populations they served. The expansion of formal schooling was however slow and often limited in the populations that were served. For instance, universal education emerged across Europe only during the past 400 years and was focused on increasing national unity and military and economic competitiveness (Goldin, 1999; Ramirez & Boli, 1987). In many areas of Europe and the Western world, the goal of universal education was not achieved until well into the nineteenth century and in some cases the early twentieth and remains to be achieved in some parts of the world today (Goldin, 1999).

These patterns highlight the evolutionary novelty of modern schools and the novelty of the competencies that are taught in them (e.g., literacy and numeracy) relative to the primary folk abilities that emerge in traditional contexts (Geary, 2002, 2007; Lancy, 2016). Nevertheless, the expansion of schooling likely resulted in some opportunity for the evolution of cognitive and motivational biases that would support academic learning. Over the past 150 years, higher levels of educational attainment have often been associated with smaller families (Graff, 1979). However, prior to this better academic competencies and associated gains in occupational status and income were generally associated with larger families and more surviving children, resulting in the potential for evolutionary selection to favor traits that motivate engagement in and facilitate academic learning (Clark, 2008; Clark & Cummins, 2015; Schultz, 1991). It is also possible that the target of selection here additionally involves brain and cognitive plasticity more broadly, that is, the ability to adapt to change and novelty in the environment (Bjorklund, 2020; Geary, 2005), which contributes to secondary learning.

Broad-based changes in brain and cognitive plasticity are not likely the whole story, however, because polygenic scores based on single nucleotide polymorphisms summed over many genes predict educational attainment (J. Lee et al., 2018; Rietveld et al., 2013) and operate in part through genetic contributions to both cognitive (e.g., intelligence; Elliott et al., 2019) and noncognitive (e.g., conscientiousness; Demange et al., 2021; Donnellan et al., 2021) influences on academic achievement. Even so, the potential for selection to operate on these traits has been very recent and prior to the last few centuries often restricted to only some segments of the population. Today, there is even some evidence for evolutionary selection against these genes due to an association with delayed marriage and consequently fewer children in the highly educated (Kong et al., 2017), that is, there might be a slow decline in the recently evolved genes that support engagement in educational settings and processes.

In any case, the key point is that the historical increases in the social and economic complexity of large-scale societies resulted in the need for at least some individuals to develop biologically secondary academic competencies, beginning with literacy and numeracy. With continued expansion of market economies, the benefits of academic competencies, including awareness of ones' academic strengths and weaknesses, increased as did the need for the expansion of formal schooling to better prepare people to live in these societies. We are now at a point where all adults need to become literate and numerate to succeed in the modern world and need to find economic niches that best fit their interests and academic strengths. These historically recent and dramatic changes in the competencies needed to prosper in modern societies means, in our opinion, that the child-initiated activities that facilitate learning in traditional contexts will not be sufficient for academic learning.

This is because there has not been sufficient opportunity for the evolution of motivational and cognitive scaffolds that will make academic learning *universally* analogous to the learning described for folk domains (Geary, 2005, 2007); for instance, in the absence of formal reading instruction, learning to read is not a continuation of natural language learning (National Institutes of Health, 2000). The historical recency of academic learning also means that academic self-concepts do not have

the same evolutionary foundations (e.g., links to inherent reward systems) as self-concepts related to social and physical traits, as mentioned earlier.

Academic Self-Concepts

Academic self-concepts are expected to be culturally specific and emerge as a result of engagement in formal schooling. Indeed, children across economically developed societies with formal schooling eventually develop differentiated academic self-concepts that are distinct from those associated with core social relationships and physical traits, as noted (Esnaola et al., 2020; Marsh & Hau, 2004; Marsh et al., 2006a, b; Rentzsch et al., 2016; Shavelson et al., 1976). Shavelson and colleagues developed one of the more influential self-concept taxonomies for students' in highly developed nations with extensive formal schooling (see also Marsh & Shavelson, 1985). On a basis of a review of the extant literature, they proposed that self-concepts are organized with a multidimensional and hierarchical structure and are composed of academic self-concepts (ASC) and non-academic self-concepts. The latter include the importance of social relationships and physical traits, as well as a self-concept associated with felt and expressed emotions.

As illustrated in Fig. 4, we retain Shavelson et al.'s (1976) basic framework and make a distinction between culture-specific (i.e., traits that are important in some but not all societies) components of self-concepts and those that are likely to be universal. Academic self-concepts are a feature of Neisser's (1988) conceptual self and should be important in contexts where formal schooling is the norm and there are strong expectations for academic achievement. These are certainly the case for children and adolescents in highly developed nations today, but these are historically recent (especially where extended universal education is the norm; Eskelson, 2020; Goldin, 1999) and thus are not universally available in some developing nations and not relevant at all in traditional contexts. Some combination of culture-specific and universal self-concepts will contribute to ones' overall global self-concept or self-esteem, but the mechanisms linking self-concepts in specific areas to overall self-concept are debated (Harter, 2006; Marsh & Shavelson, 1985).

In any case, if the evolution of a conceptual self supports cultural niche seeking and an enhanced ability to use ones' strengths in culturally important domains, such as academic learning, then self-concepts should become differentiated during development and become stable and reflective of actual competencies during adolescence, that is, before entering the competitive world of adulthood. Academic self-concepts do indeed become increasingly differentiated during schooling (Harter, 2006; Marsh & Shavelson, 1985) and are influenced by actual achievement (Valentine et al., 2004). Over time, a reciprocal relation between self-concepts and achievement in specific academic domains (e.g., mathematics or language arts) emerges, such that a more favorable earlier self-concept is associated with academic gains in that area, controlling prior achievement (Wu et al., 2021). This pattern is consistent with the co-evolution of a conceptual self and cultural niche seeking, if we assume individuals differentially invest in refining their relative strengths, as they appear

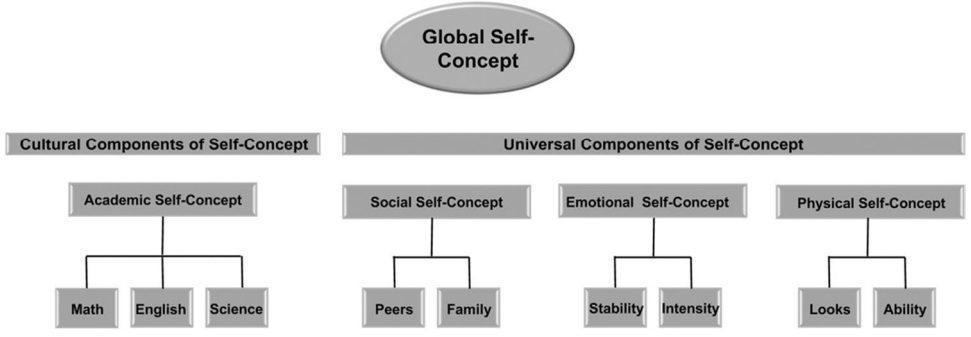

Fig. 4 Adaptation of Shavelson et al. (1976) taxonomy of self-concepts. Academic self-concepts will be central in societies in which children spend considerable time in formal educational settings, but we presume that these would include different competencies (e.g., hunting, knowledge of medicinal plants) in other cultures

to in academic (Marsh & Martin, 2011) and non-academic domains (Marsh et al., 2006a, b).

There is also some evidence that global self-concept or self-esteem is influenced by people's perception of the social value of different traits, such as physical attractiveness, and one' relative advantages on these traits. In this example, people who believe themselves to be attractive and believe others value attractiveness have a relatively high self-esteem whereas people who are low in attractiveness and discount its social value do not have substantively lower self-esteem (MacDonald et al., 2003). Marsh (1986) also found some evidence for this for physical abilities and peer relationships, but interactions between self-evaluations and perceived social value were not common. There was nevertheless evidence for a discrepancy model, whereby global self-esteem is negatively affected if the trait is perceived to be relatively important and ones' self-evaluations on this trait are relatively low. Critically, these discrepancy effects were only found for universal aspects of self-concept, including physical traits and peer relationships, but not for academic competencies.

The results are in keeping with the earlier-mentioned findings that adolescents value social relationships more than academic development and are more likely to experience negative affect when engaged in academic learning and positive affect when engaged with friends (Csikszentmihalyi & Hunter, 2003; Eccles et al., 1989; Larson & Asmussen, 1991). This is corroborated with the observations that academic self-concept and other academic competence related beliefs show declining trends during preadolescence and adolescence (e.g., Marsh, 1990; Wigfield & Eccles, 2002).

Additional support is found in comparative studies, mental health declines following COVID-19 lockdowns, and a disconnect between social popularity, self-esteem, and schooling for some adolescents. In nonhuman social species, social isolation during development is associated with various brain, cognitive, and behavioral deficits in adulthood (for review Orben et al., 2020), reflecting the disruption of species-typical developmental experiences (Fig. 3). The same types of studies cannot be conducted with people, but the social isolation associated with COVID-19 lockdowns and disruptions of children's and adolescents' relationships provides converging evidence. In a nationally representative survey of German adolescents and young adults, Rauschenberg et al. (2021) found a dose–response effect such that higher levels of lockdown-related social isolation were associated with increased risk of mental health issues (e.g., anxiety), controlling other factors (e.g., parental background). Cost et al. (2021) found that Canadian children and adolescents had increased risk of anxiety, depression, and other mental health issues after 2 to 4 months of social restrictions following COVID-19 lockdowns.

Disruptions of engagement in schooling per se, however, does not have the same negative effects on social and psychological functioning for many adolescents. There are peer groups in which strong school performance is valued, but this is not a universal feature of adolescence. Schwartz et al. (2006) found no consistent longitudinal relations between changes in social popularity and peer acceptance in adolescents and changes in school performance. One exception was that popular and aggressive students showed longitudinal declines in GPA over time as well as more absences, indicating disengagement from school. Other studies also show that global

self-esteem and can be maintained in many adolescents who disengage from academic learning (e.g., Cvencek et al., 2018). These findings are not definitive but suggest that universal aspects of development, including peer relationships, might be privileged with respect to a developing sense of self and self-esteem, and for many people might be more central to their self-esteem and overall psychological functioning than their competencies in biological secondary and culturally specific academic areas. In short, disruptions of typically occurring social relationships have a stronger effect on children's and adolescents' mental health and self-esteem than does disruptions of schooling.

Discussion

The basic argument is that academic self-concepts are a component of people's self-schema and mapped onto the evolved ability to generate conceptual or abstract representations of the self (Neisser, 1988). These conceptual self-representations are likely to emerge for folk domains, such as those related to social competencies and relationships, and other universally important traits (e.g., physical attractiveness), as well as for culturally important traits and competencies, including academic competencies in modern contexts. The latter have been extensively studied in the context of modern schooling, and thus it is easy to lose perspective and consider that engagement with schooling and academic learning is a natural part of children's typical development.

A broader evolutionary, historical, and cross-cultural perspective, however, reveals that this is not the case (Geary, 1995). Children in traditional contexts acquire many complex cognitive competencies, including the folk abilities shown in Fig. 1, and are motivated to acquire the knowledge and skills necessary to be successful in their cultures and do so without formal schooling (Lancy, 2016). They acquire these skills and knowledge through engagement in child-typical activities, such as social play, and imitating adults and more competent older children (e.g., Blurton Jones et al., 1997), and almost certainly develop self-concepts in these areas (Barkow, 1975). In these contexts, adults are not as explicitly engaged in children's learning of culturally important skills and when they are it is typically much more subtle and less frequent than the direct and active, school-based teaching that is the norm in developed societies (Legare, 2017).

The emergence of formal schooling and the need for adult organization of students' learning follows from what anthropologists call cumulative culture (e.g., Tennie et al., 2009), that is, the cross-generational retention of useful but increasingly complex knowledge and technical innovations (Geary, 2007). The expansion and accumulation of this knowledge over many millennia has created a gap between the knowledge that is easily acquired in traditional contexts and the more abstract knowledge that is needed for living in the modern world. The cognitive developmental and instructional implications of this evolutionary approach to culture and learning are currently being explored and debated (Geary & Berch, 2016; Gray, 2016; Sweller, 2021; Sweller et al., 2019), but the implications for understanding students' academic motivations and self-concepts remain to be explored.

Our goal was to develop an evolutionary framework for thinking about the development of academic self-concepts; specifically, integrating them with the self-system component of folk psychology (Fig. 1). From this perspective, academic self-concepts are supported by the evolved ability to generate and reflect on conceptual or abstract aspects of the self and ones' behavior (Leary & Buttermore, 2003; Neisser, 1988), and integrate these self-concepts with an extended self, that is, the self-knowledge that provides a sense of coherence across past, present, and potential future self-representations (Suddendorf & Corballis, 2007). The latter is important for students' understanding of how the development of academic competencies in school will influence their later success in modern economies including finding an economic niche that fits ones' interests and academic strengths, consistent with Eccles' (1983, Eccles et al., 1993) expectancy-value theory. The approach and associated empirical studies provide insights into the evolved function of self-representations and through this unique insight into core aspects of self-concepts. Evolutionary models (Flinn et al., 2005; Geary, 2005), developmental research (Rochat, 2003), and studies of the brain's default mode network (Andrews-Hanna et al., 2014; Raichle, 2015) converge on the importance of social cooperation and competition in the evolution of the self-system. The implication is that social relationships and traits that influence these relationships, including physical traits (e.g., attractiveness), will be universal foci of children's and adolescents' self-concepts, and this is the case (Esnaola et al., 2020; Rentzsch et al., 2016; Shavelson et al., 1976).

These universal self-concepts are analogous to the biologically primary folk abilities shown in Fig. 1, and culture specific self-concepts are analogous to the biologically secondary abilities (e.g., reading) that are built from folk domains. One critical implication is that the development and valuation of academic self-concepts will be more dependent on cultural activities that explicitly highlight their importance than will the development of social and physical self-concepts, just as the development of secondary abilities requires cultural institutions, including schools, and instructional practices to foster their development. A second implication is that academic self-concepts might be less central and easier to discount than social and physical self-concepts for many children and adolescents, that is, it might be easier for students to disengage from valuing academic than social and physical competencies.

In other words, explicitly focusing on the development academic competencies (e.g., reading, mathematics) to foster a positive academic self-concept in these domains is expected to be critical for all students, combined with providing exposure to successful people in these domains (e.g., Thomas Edison). The latter sends the message that academic competencies are culturally valued and a source of prestige and self-esteem, and thus might promote greater investment in their development. More generally, the approach here is a first step toward integrating the study of academic beliefs into the emerging field of evolutionary educational psychology and has the potential understand them in broader cultural, historic, and evolutionary contexts.

Authors' Contributions DCG and KMX conceptualized the proposal. KMX drafted the Academic Self-Concepts section and DCG the other sections. Both authors contributed to the refinement of all sections.

Declarations

Consent for Publication Not applicable.

Conflict of Interest The authors declare that they have no conflict of interests.

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