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## Diversity in the Development of Cognitive Flexibility: Greater Cultural Variation in Rule Switching than Word Learning

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Cognitive flexibility, the adaptation of representations and responses to new task demands, improves dramatically in early childhood. It is unclear, however, whether flexibility is a coherent, unitary cognitive trait, or is an emergent dimension of task-specific performance that varies across populations with divergent experiences. Three- to 5-year-old English-speaking U.S. children and Tswana-speaking South African children completed two distinct language-processing cognitive flexibility tests: the FIM-Animates, a word-learning test, and the 3DCCS, a rule-switching test. U.S. and South African children did not differ in word-learning flexibility but showed similar age-related increases. In contrast, U.S. preschoolers showed an age-related increase in rule-switching flexibility but South African children did not. Verbal recall explained additional variance in both tests but did not modulate the interaction between population sample (i.e., country) and task. We hypothesize that rule-switching flexibility might be more dependent upon particular kinds of cultural experiences, whereas word-learning flexibility is less cross-culturally variable.

Children live in culturally-constructed niches which consist of knowledge systems, normative practices, cultural artifacts, and social institutions that vary substantially between populations. Acquiring the specific knowledge and skills of a given social groups requires a cognitive system that is highly responsive to different ontogenetic contexts and cultural ecologies<sup>1,2</sup>. Yet virtually all young children acquire the beliefs and practices of their social group, an extraordinary learning achievement that requires substantial ontogenetic adaptability<sup>3-5</sup>.

*Flexible cognition* refers to the adaptive modification of attention, representations, and action policies in response to new task demands and ecological constraints<sup>6</sup>. It allows humans to build upon established behaviors by relinquishing old solutions and flexibly switching to more productive, efficient, or innovative ones<sup>7</sup>. It is challenging (i.e., resource-demanding) when individuals have multiple conflicting representational or behavioral options, and when they must select and integrate specific stimulus properties, task cues, and information from working and long-term memory<sup>8,9</sup>.

Cognitive flexibility works in tandem with other executive functions, including inhibition, attentional control, and working memory, to enable complex skills such as goal-directed planning, problem solving, and deliberate learning<sup>10-12</sup>. Preschool and kindergarten children's executive function test performance is correlated with academic achievement (on both mathematical and literacy assessments)<sup>13-15</sup> in the U.S., South Korea, Taiwan, and China<sup>16-18</sup>. There is also evidence for variation in measures of executive functioning between populations; East Asian children outperform Western children on measures of inhibition and cognitive flexibility (i.e., rule switching)<sup>19-23</sup>. A number of potential explanations for cultural variation in executive functioning have been proposed, including experiences in children's home and school environments. For example, urban preschool children in China tend to receive consistent, high-demand training related to rule following and self-regulation in school and home environments<sup>24,25</sup>.

Cognitive flexibility, like other executive functions, improves dramatically from 3 to 6 years<sup>26-28</sup>. During this age span, children (from high socioeconomic status [SES] communities most widely studied in the developmental literature<sup>2</sup>) improve in switching between verbal rules for sorting cards<sup>29</sup>, in using changing semantic cues

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