Journal of Behavioral Health
www.scopemed.org
DOI: 10.5455/jbh.20160914121148

Original Research

Assessment of attention level among Chinese and Israeli adolescents

Dubi Lufi[1], Yun-Kwok Wing[2], Ngan-Yin Chan[3]

[1]Department of Behavioral Sciences, Yezreel Valley College, Israel, [2]Department of Psychiatry, Faculty of Medicine, The Chinese University of Hong Kong, China, [3]Department of Psychiatry, Faculty of Medicine, The Chinese University of Hong Kong, China

Address for correspondence: Dubi Lufi, Department of Behavioral Sciences, Yezreel Valley College 19300, Israel. Tel.: +91-97246548880. Fax: 97246548600. E-mail: dubilufi@gmail.com, dubil@yvc.ac.il

Received: July 16, 2016
Accepted: September 04, 2016
Published: October 03, 2016

ABSTRACT

Background: The purpose of the present study was to compare the attention level of Chinese adolescents (mean age = 15.03) to that of Israeli adolescents (mean age = 14.67). **Methods:** Participants included 386 "normal" adolescents who responded to a computerized test assessing attention (mathematics continuous performance test [MATH-CPT]). No differences were found between males and females on any of the 11 main measures of the MATH-CPT. **Results:** The results indicated that Israeli adolescents performed better on three of the attention measures ("overall attention level," "consistency in reaction time," and "anticipatory responses"). The Chinese adolescents performed better on one measure: "Consistency of reaction time along the whole test" (sustained attention of standard deviation [SD]). The authors discuss the results by hypothesizing that the differences between the two groups can be explained by a possible sluggish tendency among Chinese adolescents, which may be connected to a holistic reasoning style as compared to an analytic reasoning style among the Israelis. The superior performance of Chinese adolescents on the "sustained attention of SD" can be explained by the tiredness of the Israeli adolescents due to the effort they exerted during testing. **Conclusions:** The results emphasized cultural differences between two cultures in the assessment of a quantitative measure of attention. Our results show that cultural diversity can be described by more accurate measures of a computerized test. The results support a well-known fact about differences between Eastern and Western cultures: Holistic (Eastern) versus analytic processing (Western) can create different quantitative outcomes in the assessment of attention level.

KEY WORDS: Analytic style of reasoning, attention and cultural differences, attention, computerized-testing, cultural-differences, holistic style of reasoning

CROSS-CULTURAL ASSESSMENT OF ATTENTION LEVEL AMONG CHINESE AND ISRAELI ADOLESCENTS

Differences in cognitive styles between Eastern and Western cultures have been a popular area of investigation. Historically, differences between Western and Eastern cultures can be traced back to Greek and Chinese philosophy [1]. Examination of the cognitive differences between East and West in the context of cross-cultural differences has shown that East Asians are less likely than North Americans (a) to predict that current trends will be maintained in the future [2]; (b) to categorize objects, understand events, and use rules and formal logic [3,4]; (c) to exhibit tolerance for contradiction [5,6]; (d) to make dispositional causal inferences [7].

Among the many cross-cultural studies to date, probably the most extensively studied domain is attention [8]. Traditionally, attention and memory were considered to be universal abilities not bound by cultural aspects [9]. This line of thinking changed when it was discovered that Western cultures tend to emphasize the independence of individuals, whereas Eastern cultures emphasize interdependence and social relations [10-12]. Research investigating the relationship between attention and culture has reported that Western-oriented cultures are more oriented toward focused attention or place more focus on a centrally relevant object and less on the surrounding context. In contrast, Eastern-oriented cultures have been found to have broader or more distributed attention, meaning that they are more influenced by context. Using different terms, other researches [13] stated that Asians attend more to aspects of environment and relationships, whereas Americans focus more on focal objects. Fu *et al.* [14] referred to this issue by describing an animated underwater scene. They stated that Japanese look first at the background of the scene (e.g., at the pool), whereas Americans usually refer to the focal object (e.g., the fish in the pool).

Similar findings were obtained for different perceptual judgment tasks [15-17]. Several researchers referred to this as a discrepancy between holistic and analytic modes of thinking or as a difference in locus of attention [16,18,19]. Kim *et al.* [18] explained this issue by stating that individuals oriented to Western culture "tend to adopt an analytic style of reasoning that is characterized by the tendency to attend primarily to focal information, and attribute causes of a social event to

internal and dispositional factors. While people from Eastern cultural contexts tend to adopt a holistic style of reasoning that is characterized by the tendency to attend to the entire field and attribute the causes of the social events to external situational factors" (p. 212).

Among studies investigating Eastern versus Western culture with respect to attention, few have been conducted with children. Some studies found attentional differences among 6-year-old children, indicating that cultural differences in attentional style may develop at an early age [20-22]. Duffy *et al*. [20] found that Japanese children aged six and over performed better on a relative task (holistic attention) than did American children in the same age group, who performed better on an absolute task (focused attention). No such differences were found among younger children. The study concluded that socio-cognitive development and socialization processes occurring between the ages of five to seven are important in fostering culturally specific attention tendencies. Contradicting these findings, others [23] suggested that cultural differences in context-sensitivity may be present as early as the age of four. Imada *et al*. [8] found that Japanese children had greater context-sensitivity than did American children. The issue of context-sensitivity still needs more investigation, as was pointed out by the findings of Ji [24], who observed a developmental increase in cultural differences between the ages of 7 and 11.

Using a computerized continuous performance test (CPT) (Test of Attentional Performance for Children - KITAP), researchers [25] found that Syrian children (considered to represent Arabic-collectivistic-dependent culture) had more variable responses, slower performance, and more errors compared to German children (considered to represent Western-individualistic-independent culture). These researchers concluded their study by indicating that attention level can be influenced by cultural background characteristics.

Not too many studies have assessed cross-cultural differences among adolescents using CPT. The present study aimed to fill this gap using a computerized test to compare the attention level of adolescents in China (considered representative of Eastern-oriented culture) to that of adolescents in Israel (considered representative of Western-oriented culture). The importance of such studies is that CPT tests are computerized tests; they are more accurate and more reliable. Computerized tests of attention do not assess the holistic versus analytic mode of attention. Therefore, the hypothesis in the current study cannot rely on previous studies. The study hypothesis was that no differences would be found in the level of attention between Chinese and Israeli adolescents as measured by one computerized test.

METHODS

Participants

A total of 386 adolescents participated in the study: 196 monolingual Chinese adolescents, 103 males, and 93 females, with a mean age of 15.03 (standard deviation [SD] = 0.83) were compared to 190 monolingual Israeli adolescents, 113 males and 77 females, with mean age 14.67 (SD = 1.28). All participants ranged in age from 13 to 17 years old. The participants from China resided in Hong Kong and attended one co-educational public secondary school located in the Tai Po district, one of the 18 districts in Hong Kong. The participants from Israel all lived in Northern Israel in towns and cities numbering no more than 50,000 people. All the participants in both groups attended regular schools and were from midrange SES. There was no record of any learning disabilities or attention-deficit hyperactivity among the participants from China and Israel.

The experiment conformed to the principles outlined by the institutional ethics of the Chinese University of Hong Kong and Yezreel Valley College. All the participants volunteered to participate in the study with no financial reward. This research received no specific grant from any funding agency.

Instruments

The measure of attention used in the study was the mathematics CPT (MATH-CPT) [29]. The MATH-CPT is a computerized CPT-type test; it uses a sequence of 450 simple mathematical problems involving addition, subtraction, multiplication, and division. The test designed to assess attention. The answer to any given question was never >9 and was projected on a computer screen to serve as a visual stimulus. During the test, one problem appeared on the screen together with the result that could be right or wrong (e.g., $1 + 4 = 5$, or $4 \times 2 = 7$). The participants observed one problem at a time on the computer screen and had to decide whether the solution to the problem was correct or incorrect by pressing "1" for a correct answer or "2" for an incorrect answer. The test stimuli were more complicated than in most other CPT-type tests. An open reaction time procedure allowed participants to react at their individual pace of activity. The test lasted approximately 10-20 min, depending on the reaction time of each participant. The test included the following main measures: A final overall attention level formula to assess a participant's overall attention level; reaction time (average time taken to respond to each problem); SD of reaction time (a measure of reaction time variability); impulsive responses included: (a) A guessing fast response given at a speed of <0.5 s and (b) incorrect fast responses, they were defined as incorrect responses that were given at a faster rate than each participant's average reaction time. Both considered measures of impulsivity; accuracy of responses (correct answers, considered a measure of attention).

The test's four secondary measures assessed sustained attention within the test: Sustained attention over time; sustained attention based on SD; sustained attention based on correct responses; sustained attention based on impulsivity. Each measure was calculated using a form of performance over nine parts of the test. These four measures of sustained attention assessed a possible reduction, improvement, or no change in performance on measures in their respective areas and were based on an algorithm designed specifically to assess these domains. The algorithm to assess sustained attention was based

on a calculation of the nine blocks each of 50 mathematical problems. The nine blocks run consecutively without breaks and had the same structure for all the participants. In the calculation, each block, from the first to the ninth in ascending order, contributed more weight to the total measure of sustained attention. The result was a single number assessing sustained attention for each of the four measures.

During construction of the MATH-CPT, test-retest reliability after 1 week of testing with the main measures used in the MATH-CPT indicated an average correlation of 0.73 for the test's main measures. During development of the MATH-CPT, a discriminant function analysis was used to compare a control group (without attention-deficit hyperactivity disorder-ADHD) to a group with ADHD. The results indicated that the test can correctly identify 90.80% of participants in both groups. The reason the MATH-CPT was chosen for this study over other commonly used CPTs is that it has four different "on the test" measures of sustained attention, and it used as stimuli numbers known to both cultures.

PROCEDURE

Participants in the study were recruited from co-educational public schools in Hong Kong, China, and in the Yezreel Valley in Northern Israel. The test was administered to both populations before 1:00 PM to avoid the effects of being tired later in the day. After receiving instructions for the test in Chinese or Hebrew, participants answered 30 sample problems from the MATH-CPT administered to every person who took the test. Immediately after answering the sample problems, the participants responded individually to the 450 problems comprising the entire MATH-CPT test.

The Chinese and the Israeli participants used similar computers, PC computers with a 17-inch screen. The stimuli were white numbers on a black screen with a size of approximately 1.0 cm^2. The same identical software of the MATH-CPT program was installed in the computers in China and Israel. The stimuli of mathematical problems appeared in the same sequence for all the participants. The proportion of mathematical problems of addition, subtraction, multiplication, and a division was about 25% from each category. A more complicated stimulus was used by the MATH-CPT to avoid ceiling effect (explanation in Lufi and Fichman, 2012 [27]). The main formula of the overall attention level was calculated using discriminant function analysis comparing clients who were diagnosed as having ADHD to participants who did not have ADHD, or learning disabilities (explanation in Lufi and Fichman, 2012 [27]). The main formula of the overall attention level included several variables of the test, with the measures of "reaction time" and "correct responses," are carrying more weight in calculating the main formula of overall attention level.

RESULTS

All the results were analyzed with the help of SPSS 21.0. A composite score was calculated for each participant; these scores served further statistical analysis. The results for males and females were compared to assess the possible influence of gender differences. Using independent samples *t*-test, with all the Chinese and Israeli participants, showed no differences between males and females on all 11 main and secondary measures of attention provided by the test (these findings are similar to results achieved during standardization of the test). These results allowed the researchers to continue the analysis without taking gender into consideration. The results indicated that the Israeli adolescents scored significantly better on three of the 11 measures of the MATH-CPT, whereas the Chinese adolescents scored better on one measure. On overall attention level, the main measure of the MATH-CPT, Israeli adolescents had a performance of (mean = −0.77, SD = 0.74), as compared to the Chinese students (mean = −0.59, SD = 0.92, $t = 2.07$, $P < 0.05$ [here, a smaller number indicates better attention level]). Israeli adolescents demonstrated greater consistency in reaction time through a smaller SD of reaction time (mean = 0.85, SD = 0.45), as compared to Chinese adolescents (mean = 1.09, SD = 0.45, $t = 5.14$, $P < 0.001$). The Israeli adolescents had fewer anticipatory responses, which are a measure of impulsivity (mean = 0.38, SD = 0.91), than did the Chinese adolescents (mean = 1.21, SD = 2.14, $t = 4.99$, $P = 0.001$). The Chinese adolescents had better scores in sustained attention of SD, which measured the consistency of reaction time along the whole test (mean = −0.15, SD = 0.44), as compared to the Israeli adolescents (mean = 0.06, SD = 0.27 [here, a smaller number indicated better score], $t = 1.99$, $P = 0.05$). On the other seven measures of the MATH-CPT, there were no significant differences between the two groups. These results are depicted in Table 1.

The results of the four measures of the secondary measures (the measures of sustained attention) are shown in Figures 1-4. They illustrate the progression of the two groups along the nine tests' blocks.

DISCUSSION

The study compared attention levels among adolescents in Hong Kong, China, and in Israel using one standardized computerized test. The results allowed the researchers to conclude that Israeli adolescents performed better on three measures of the test, whereas Chinese adolescents scored better on one measure. On the test's main measure, "overall attention level," which is a summary of the test's results-Israeli adolescents scored slightly better. Greater differences between the two groups were found on measures of "SD of the reaction time," which is considered to represent response consistency and "anticipatory responses," which is considered a measure of impulsivity. Chinese adolescents scored better on the measure of "sustained attention - SD," which measured consistency of reaction time along the whole test.

Overall, cultural differences on attention performance were observed for few domains of the MATH-CPT. There were no significant differences between the two groups on 7 out of the 11 measures, while for the remaining four measures,

Table 1: Means, standard deviations, *t*-scores, Cohen'-d of the main MATH-CPT variables, comparing Chinese and Israeli adolescents

Variable	Mean±SD		Effect size	
	Chinese adolescents	Israeli adolescents	*t*	Cohen's d[b]
Main measures				
Overall attention[a]	−0.59±0.92	−0.77±0.74	2.07*	0.21
Total reaction time (minutes)[a]	12.81±2.93	13.36±3.78	1.60	0.16
Consistency (SD time)[a]	1.09±0.45	0.85±0.45	5.14**	0.52
Anticipation (impulsivity)[a]	1.21±2.14	0.38±0.91	4.99**	0.51
Fast wrong responses[a]	13.35±7.29	12.83±7.51	0.61	0.06
Total impulsivitya	14.57±8.04	13.25±7.68	1.44	0.15
Correct responses (attention)	429.21±11.48	430.02±9.30	0.77	0.08
Secondary measures				
Sustained Reaction time[a]	−6.30±13.04	−3.92±10.86	1.94	0.20
Sustained SD[a]	−0.15±0.44	0.06±0.27	1.99*	0.20
Sustained impulsivitya	0.04±1.51	−0.23±1.15	1.95	0.20
Sustained correct responses	0.24±1.64	0.29±1.08	0.31	0.31

*$P<0.05$. **$P<0.01$. [a]Denotes that lower score indicates better performance, [b]Based on Cohen's (1988) classification, *d*s of 0.20−0.49 are considered small, *d*s of 0.50−0.79 are considered moderate, and *d*s equal to or above 0.80 are considered large. MATH-CPT: Mathematics continuous performance test. SD: Standard deviation

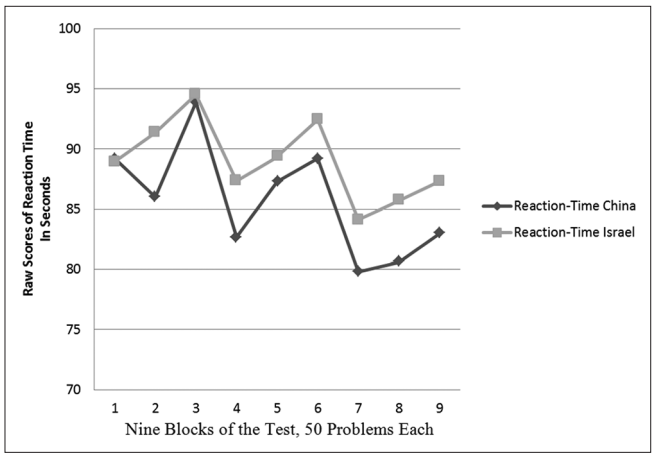

Figure 1: Raw scores of total reaction time in seconds, over nine blocks of the mathematics continuous performance test, a lower score denotes a better performance

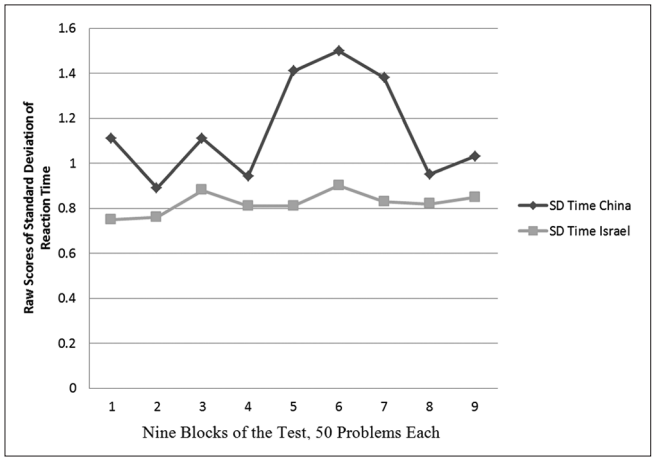

Figure 2: Raw scores of standard deviation of reaction time, over nine blocks of the mathematics continuous performance test, a lower score denotes a better performance

significant differences were observed between Chinese and Israeli adolescents (SD of reaction time, considered to measure consistency of responses; anticipatory responses, considered to be a measure of impulsivity; overall attention level; sustained attention SD, measuring consistency of reaction time along the test).

In an attempt to understand the differences between the two groups on the test's main measure, "the final attention formula" raises possible hypotheses. Sluggish cognitive tempo, a term coined and discussed [30], is a problem appearing in children characterized as passive, daydreaming, hypoactive, confused, slow-moving, and sluggish. The differences found in our study between adolescents from an Eastern-oriented culture and those from a Western-oriented culture may be caused by the fact that Asians attend more to objects appearing in the environment while Westerns focus more on focal objects [14]. Support for this phenomenon may lie in the pictographic nature of the Chinese characters. A written Chinese word may include several sets of strokes, each of which may represent a different word. Paying attention to the separate sets of strokes, rather than the overall picture, may confuse the reader (Cohen, personal communication, August 9, 2016). This tendency may cause the Chinese adolescents to be less focused and perform poorer on a task requiring quick and accurate responses. A second possible explanation for our results is based on the results of a study by Chang *et al.* [30], which found that individuals from East and South Asia had a smaller amount of 7-allele of the dopamine D4 receptor gene, a component responsible for maintaining attention in the brain.

With respect to the SD of reaction time, which measured the consistency of reaction time, several studies have considered this to be one of the most important variables of attention [29]. It is possible that cultural differences may influence the level of consistency during the performance. People from Eastern cultures are thought to be more relaxed and calm, perhaps causing them to be less alert and more inconsistent on tasks requiring precise work within a limited time.

In attempting to understand the differences between the groups on anticipatory responses, the anticipatory responses were

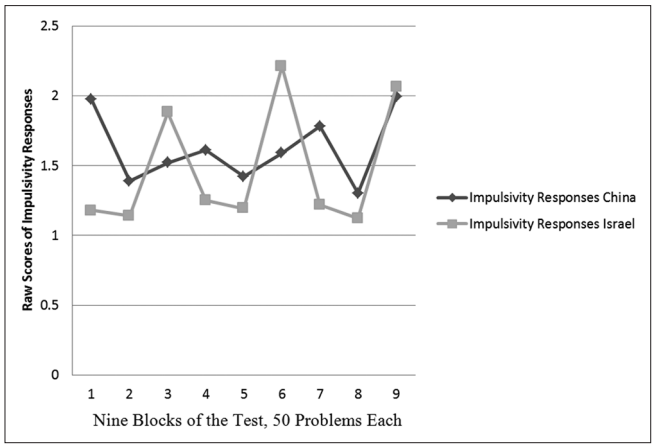

Figure 3: Raw scores of impulsivity responses, over nine blocks of the mathematics continuous performance test, a lower score denotes a better performance

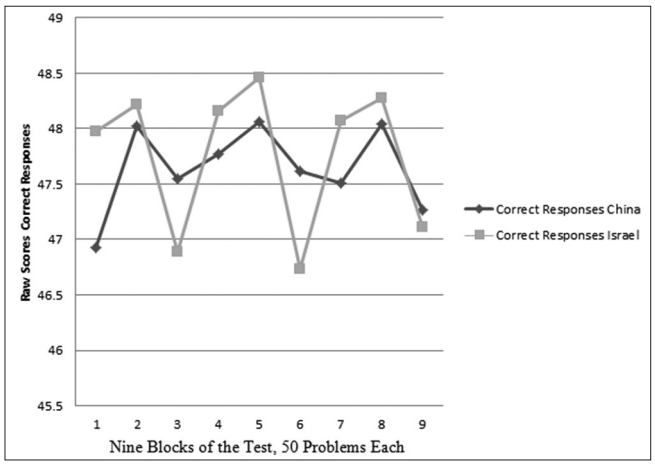

Figure 4: Raw scores of correct responses, over nine blocks of the mathematics continuous performance test, a higher score denotes a better performance

considered a measure of impulsivity. Thus, these results may be explained by differences in temperament between the two cultures, where people from Eastern-oriented cultures tend to be more impulsive and short tempered than those from Western-oriented cultures. These results are strengthened by the fact that the Chinese adolescents had faster reaction time on the test, although the differences were not significant.

The fact that the Chinese adolescents had superior performance on one variable, "sustained attention - SD" which measured consistency of reaction time along the whole test, raises the hypothesis that being more passive allowed the Chinese participants to maintain their consistency along the test better than the Israelis, who got tired because of their effort to perform well.

The study has some limitations. One is that the study used only one measure of attention. Although CPT-type tests are less influenced by tester errors due to the use of a computerized test, other measures of attention can verify the findings reached in the present study. Moreover, using other age groups, both younger and older could help generalize the results and lead to a deeper understanding of the effect of cultural differences on attention. In addition, the Chinese adolescents were only recruited from one public school in Hong Kong. It is likely that there are significant variations across various groups of adolescents, which further limited the generalizability of the study. Thus, it is important to replicate these findings using community samples to discover the cultural differences.

The results of the study demonstrate important cultural differences between two cultures in the assessment of a quantitative measure of attention. Most other studies assessing cultural differences in attention assessed more qualitative aspects of attention. Our results show that cultural diversity can be explained by more accurate measures that assess attention. The results also suggest that a well-known fact about differences between Eastern and Western cultures (holistic vs. analytic processing) can have quantitative outcomes in the assessment of attention level.

REFERENCES

1. Markus HR, Kitayama S. Culture and the self: Implications for cognition, emotion, and motivation. Psychol Rev 1991;98:224-53.
2. Ji LJ, Nisbett RE, Su Y. Culture, change, and prediction. Psychol Sci 2001;12:450-6.
3. Ji LJ, Zhang Z, Nisbett RE. Is it culture or is it language? Examination of language effects in cross-cultural research on categorization. J Pers Soc Psychol 2004;87:57-65.
4. Norenzayan A, Smith EE, Kim BJ, Nisbett RE. Cultural preferences for formal versus intuitive reasoning. Cogn Sci 2002;26:653-84.
5. Choi I, Nisbett RE. Cultural psychology of surprise: Holistic theories and recognition of contradiction. J Pers Soc Psychol 2000;79:890-905.
6. Peng K, Nisbett RE. Culture, dialectics, and reasoning about contradiction. Am Psychol 1999;54:741-54.
7. Morris MW, Peng K. Culture and cause: American and Chinese attributions for social and physical events. J Pers Soc Psychol 1994;67:949-71.
8. Imada T, Carlson SM, Itakura S. East-West cultural differences in context-sensitivity are evident in early childhood. Dev Sci 2013;16:198-208.
9. Wang, Y. On cognitive informatics. Brain and mind: A transdisciplinary. J Neurosci Neurophilosophy 2003;4:151-67.
10. Church AT, Katigbak MS, Ortiz FA, Del Parado AM, Vargas-Flores JD, Iba´nez-Reyes J, *et al.* Investigating implicit trait theories across cultures. J Cross Cult Psychol 2005;36:476-96.
11. Church AT, Katigbak MS, Del Prado AM, Ortiz FA, Mastor KA, Harumi Y, *et al.* Implicit theories and self-perceptions of traitedness across cultures: Toward integration of cultural and trait psychology perspectives. J Cross Cult Psychol 2006;37:694-716.
12. Kanagawa C, Cross SE, Markus HR. Who am I? The cultural psychology of the conceptual self. Pers Soc Psychol B 2001;27:90-103.
13. Cohn N, Taylor-Weiner A, Grossman S. Framing attention in Japanese and American comics: Cross-cultural differences in attentional structure. Front Psychol 2012;3:1-13.
14. Fu Q, Dienes Z, Shang J, Fu X. Who learns more? Cultural differences in implicit sequence learning. PLoS One 2013;8:e71625.
15. Chua HF, Boland JE, Nisbett RE. Cultural variation in eye movements during scene perception. Proc Natl Acad Sci U S A 2005;102:12629-33.
16. Nisbett RE. The Geography of Thought: How Asians and Westerners Think Differently – And Why. New York: Free Press; 2003.
17. Nisbett RE, Miyamoto Y. The influence of culture: Holistic versus analytic perception. Trends Cogn Sci 2005;9:467-73.
18. Kim HS, Sherman DK, Taylor SE, Sasaki JY, Chu TQ, Ryu C, *et al.* Culture, serotonin receptor polymorphism and locus of attention. Soc Cogn Affect Neurosci 2010;5:212-8.
19. Nisbett RE, Peng K, Choi I, Norenzayan A. Culture and systems of thought: Holistic versus analytic cognition. Psychol Rev

2001;108:291-310.
20. Duffy S, Toriyama R, Itakura S, Kitayama S. Development of cultural strategies of attention in North American and Japanese children. J Exp Child Psychol 2009;102:351-9.
21. Miyake K, Chen SJ, Campos JJ. Infant temperament, mother's mode of interaction, and attachment in Japan: An interim report. Monogr Soc Res Child Dev 1985;50:276-97.
22. Shweder RA, Jensen LA, Goldstein WM. Who sleeps by whom revisited: A method for extracting the moral goods implicit in practice. New Dir Child Dev 1995;67:21-39.
23. Kuwabara M, Son JY, Smith LB. Attention to context: U.S. And Japanese children's emotional judgments. J Cogn Dev 2011;12:502-17.
24. Ji LJ. The leopard cannot change his spots, or can he? Culture and the development of lay theories of change. Pers Soc Psychol Bull 2008;34:613-22.
25. Sobeh J, Spijkers W. Development of neuropsychological functions of attention in two cultures: A cross-cultural study of attentional performances of Syrian and German children of pre-school and school age. Eur J Dev Psychol 2013;10:318-36.
26. Swanson JM, Sunohara GA, Kennedy JL, Regino R, Fineberg E, Wigal T, *et al*. Association of the dopamine receptor D4 (DRD4) gene with a refined phenotype of attention deficit hyperactivity disorder (ADHD): A family based approach. Mol Psychiatr 1998;3:38-41.
27. Lufi D, Fichman N. Development and use of a computerized test, MATH-CPT, to assess attention. Percept Mot Skills 2012;114:59-74.
28. Milich R, Ballentine AC, Lynam DR. ADHD/combined type and ADHD/predominantly inattentive type of distinct and unrelated disorders. Clin Psychol Sci Pract 2006;8:463-88.
29. Greenberg LM, Kindschi CL, Corman CM. Test of Variables of Attention (TOVA): Clinical Guide. Los Alamitos, CA: Universal Attention Disorders; 1999.
30. Chang FM, Kidd JR, Livak KJ, Pakstis AJ, Kidd KK. The world-wide distribution of allele frequencies at the human dopamine D4 receptor locus. Hum Genet 1996;98:91-101.

Source of Support: Nil, Conflict of Interest: None declared.