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# Characteristics of Inattention and Hyperactivity, Perception of General Health, and Reading Literacy of Japanese Adolescents: Results from a Large-scale Community Sample

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Adolescents with reading literacy difficulty with comorbid attention deficit hyperactivity disorder are often at a greater risk for problems of communication, and behavioral and mental health challenges. We aimed to examine literacy weakness for the native Japanese language of KOKUGO and the foreign language of ENGLISH as perceived by Japanese adolescents. We also aimed to analyze the relationship between literacy weakness and inattention and hyperactivity characteristics. We conducted a large-scale questionnaire survey of 2987 junior high school students. We used logistic regression analysis to examine the data from the self-report Strengths and Difficulties Questionnaire (SDQ), the General Health Questionnaire-12, and adolescents' perceptions of their command of KOKUGO and ENGLISH. We found a significant association between perceived literacy for both languages and SDQ inattention and hyperactivity characteristics. Reading difficulties in ENGLISH may be addressed by introducing ENGLISH at an earlier age supported by clinically enhanced pedagogy.

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**Key words:** Attention deficit hyperactivity disorder, General Health Questionnaire, Grade level, Literacy weakness in KOKUGO and ENGLISH

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## Introduction

According to a national survey conducted on the literacy weakness of students in public elementary and junior high schools, 2.4% of students experience extreme difficulties in reading and/or writing,<sup>1</sup> and this has become a major educational, social, and political concern. Researchers usually class children and adolescents experiencing such difficulties as having dyslexia or specific reading difficulties.<sup>2</sup> However, the concepts of dyslexia are so diverse and extensive ranging from anyone who struggles with decoding to a much narrower set of children whose decoding difficulties are un-

pected relative to their intellectual skills and life circumstances, or may be assumed to be biologically determined.<sup>3</sup> Nonetheless, dyslexia is a term applied to those children who unexpectedly fail to learn to read, whether defined based on significant reading underachievement or relative to expectations based on IQ, age, or grade level.<sup>4</sup> Prevalence rates for reading disorder (RD) vary; rates of 3%–17.5% have been reported for the USA.<sup>5–7</sup> In Japan, the prevalence rates for reading difficulties in the native language of KOKUGO differ according to the three writing orthographies that make up Japanese sentences: hiragana 0.2%, katakana 1.4%, and kanji 6.9%.<sup>8</sup>

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There is a high likelihood of comorbidity between problems with reading literacy and characteristics of attention deficit hyperactivity disorder (ADHD). As a result, reading difficulties may manifest in both behavioral and mental disorders, and may show gender differences, with more boys having RD.<sup>9</sup> Boys tend to externalize their disruptive behaviors, whereas girls with RD tend to exhibit internalizing symptoms and somatic complaints.<sup>10</sup> Furthermore, excess risk has been reported in both community and clinical cases;<sup>11</sup> the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) reports that the prevalence of specific learning disorders across domains of reading, writing, and mathematics is 5%–15% among schoolchildren across languages and cultures and the prevalence of ADHD in children in most countries is about 5%.<sup>12</sup> The prevalence rate of comorbidity between the two disorders among all school-aged children in the USA is an estimated 4%,<sup>13</sup> and up to nearly one-third (15%–30%) of children diagnosed with ADHD have a concurrent diagnosis of RD.<sup>14–15</sup> Other researchers have shown that children with ADHD comorbid with RD (ADHD + RD) have deficits in semantic processing associated with RD, and in the higher-order executive function of ADHD.<sup>10</sup>

An issue of importance to both public policy and educational practice in Japan is the drastic discrepancy between the results of literacy performance (reading performance) in native KOKUGO and in ENGLISH, which is taught compulsorily. According to the Organization for Economic Cooperation and Development's Program for International Scholastic Assessment report, Japan ranked 8th in the world in reading comprehension performance in the native language.<sup>16</sup> Nonetheless, the Institute for Management Development ranked Japan's foreign language skills 58th out of 59 countries in 2011.<sup>17</sup> Moreover, data from the internet-based test of English as a foreign language (TOEFL) ranked Japan's foreign language skills as 137th among 163 countries in the world and 27th among 30 Asian countries.<sup>18</sup>

Faced with the lack of a standardized definition of dyslexia and no large-scale screening tests valid for Japanese children, additional information is needed to accurately classify students into special reading assessment and intervention programs in Japan such as Response to Intervention (RTI).<sup>19</sup> Therefore, we needed to investigate how many students perceive difficulties in learning KOKUGO and/or ENGLISH (and which areas they perceive as difficult) and whether students report any association between their reading challenges and characteristics of inattention and hyperactivity.

The aims of present study were 1) to examine literacy weakness in KOKUGO and ENGLISH in Japanese adolescents; 2) to compare literacy weakness patterns between

genders; 3) to investigate the relationship between literacy weakness and inattention and hyperactive characteristics; and 4) to analyze factors associated with literacy weakness in KOKUGO and ENGLISH using a multivariate model. The rationale for examining these two languages was partially derived from three of the most essential differences between the languages. First, the nature of letter-to-sound correspondence at the level of both visual and auditory decoding; in KOKUGO, one mora corresponds invariably with one grapheme, whereas in English, one grapheme corresponds with many phonemes. Second, the most common type of kanji used in Japan contains two components: a phonetic reading called ON (clue to the Chinese sound) and a radical reading called KUN (clue to the Japanese sound and meaning).<sup>20</sup> Third, Japanese sentences are generated using three phonetic orthographies: hiragana, katakana, and logographic kanji. In contrast, ENGLISH sentences are generated by using only one orthography; the alphabet system.

## Methods

### Participants

Adolescents (N = 2987) attending seven public junior high schools in the Nagasaki City area from December 2010 to January 2011 completed the self-report surveys during their homeroom hours. As the new academic year in Japan starts in April, participants' ages ranged from 12 to 15 years and their grade levels ranged from 7–9th grade. At the time of this survey, participants were receiving a conventional compulsory education in both their native KOKUGO and ENGLISH.

### Measures

#### *Literacy measures*

Reading level was assessed using a 5-point Likert scale with the following responses: "very weak"=1, "somewhat weak"=2, "average"=3, "somewhat strong"=4, and "very strong"=5. The response categories included reading hiragana (mora-based Japanese alphabets), reading kanji (Chinese characters), and sentence comprehension. The level of sentence comprehension depended on the students' ability to learn different writing systems (hiragana, katakana, and kanji) that make up Japanese sentences. For English, students reported about reading English words, English pronunciation, and sentence comprehension.

#### *Strengths and Difficulties Questionnaire*

We used the Inattention and Hyperactivity subscales of

the Strengths and Difficulties Questionnaire (SDQ) to evaluate the presence of inattention and hyperactivity characteristics. The SDQ is a widely used behavioral screening questionnaire with established reliability and validity that can be administered to 11 to 16-year-olds. Goodman et al. reported that the SDQ's sensitivity and specificity for any psychiatric disorder were 63.3% and 94.6%, respectively, and that the sensitivity for any ADHD disorder (DSM-IV) was 75.4%.<sup>21</sup> SDQ behaviors are rated on a 3-point scale: responses of "not true," "somewhat true," and "certainly true" are scored as 0, 1, and 2, respectively. The SDQ contains two inattention items (e.g., "I am easily distracted, I find it difficult to concentrate"), and three hyperactivity items (e.g., "I am restless, I cannot stay still for long"). Inattention scores range from 0 to 4 and hyperactivity scores range from 0 to 6.

#### *General Health Questionnaire*

Participants' mental health was assessed using the Japanese version of the 12-item General Health Questionnaire (GHQ-12). The 12 items (e.g., "Have you recently been able to enjoy your normal day-to-day activities?") are completed using a 4-point scale, with higher scores indicating poorer mental health. Scores range from 0 to 12. Based on previous studies, students with GHQ scores  $\geq 4$  were placed in the poor mental health group.<sup>22</sup> Honda et al. have reported a specificity of 78.0% and a sensitivity of 56.9% for the GHQ-12, and the reliability of the scale is good, as indicated by a high Cronbach's alpha coefficient.<sup>23</sup>

#### **Statistical analyses**

We classified participants based on their literacy weakness in reading hiragana, reading kanji, and sentence comprehension for KOKUGO, and their literacy weakness in reading words, pronunciation, and sentence comprehension for ENGLISH by gender. The number of literacy weaknesses (perceived as "very weak") was summed for KOKUGO and ENGLISH. The patterns in perceived literacy weakness in each area of the languages and the sum of the reading literacy weaknesses were compared between genders using the Cochran-Armitage test. The distributions of the SDQ inattention and hyperactive scores and the GHQ-12 scores were compared for those who had "very weak" areas of literacy and those who did not. The Mann-Whitney U test was used, because the Kolmogorov-Smirnov test showed that the distribution of each score was non-normal. Logistic regression analyses were used to investigate factors associated with literacy weakness in KOKUGO and ENGLISH. The dependent variable was whether very weak literacy was experienced or not, and the independent

variables were the SDQ scores of inattention and hyperactive characteristics, GHQ-12 scores, grade level, and gender. Gender-specific analyses were also applied. The regression coefficients, standard errors, and  $p$  values were estimated, and the Cox-Snell R-squared value was calculated from the logistic regression analyses.

#### **Ethical considerations**

This questionnaire survey was approved by the ethics committee of Nagasaki University and was conducted in compliance with the approved implementation procedures. The approval number is 09121737. Ethical considerations included (1) anonymous submission of survey responses, (2) students who did not wish to participate in the survey submitted a blank sheet of paper in an envelope, and (3) students placed the completed surveys in envelopes before submission so that no school personnel could access them. Requests to participate in this survey were made to each individual school and written consent was obtained from the principal of each school. Written explanations of the survey were distributed to the participating students, and to their parents or guardians. Every classroom teacher received instructions from us on how to complete the survey, and read them before taking part. The same instructions were read to all participating students before the survey began.

#### **Results**

Table 1 shows the percentages of students who perceived they were very weak in hiragana reading (1.3%), kanji reading (2.8%), and comprehension (10.0%) in KOKUGO and the percentages of those who perceived they were very weak in reading words (13.8%), pronunciation (12.3%), and comprehension (18.7%) in ENGLISH. There was a statistically significant gender difference for hiragana reading and comprehension in KOKUGO and for pronunciation in ENGLISH.

Table 2 shows the sum of the perceived literacy difficulties in KOKUGO and ENGLISH by gender. For KOKUGO, 11.2% of the students perceived they were very weak in at least one of the areas of hiragana reading, kanji reading, or comprehension. For ENGLISH, 23.5% of the students perceived they were very weak in at least one of reading words, pronunciation, or comprehension. The results in Table 2 also indicate that boys showed more areas of weakness than girls in the two languages ( $p < 0.001$  for KOKUGO and  $p = 0.009$  for ENGLISH).

Table 3 shows literacy in KOKUGO, associated inattention and hyperactivity scores, and mental health characteristics

**Table 1.** Patterns of literacy “weakness” responses for KOKUGO and ENGLISH by gender.

		Gender		Total (n=2987)	P <sup>a</sup>
		Male (n=1464)	Female (n=1523)		
<b>KOKUGO</b>					
Hiragana Reading	Very Weak	29 ( 2.0%)	10 ( 0.7%)	39 ( 1.3%)	0.001
	Somewhat Weak	46 ( 3.1%)	40 ( 2.6%)	86 ( 2.9%)	
	Average	254 (17.3%)	235 (15.4%)	489 (16.4%)	
	Somewhat Strong	233 (15.9%)	222 (14.6%)	455 (15.2%)	
	Very Strong	902 (61.6%)	1016 (66.7%)	1918 (64.2%)	
Kanji Reading	Very Weak	54 ( 3.7%)	31 ( 2.0%)	85 ( 2.8%)	0.810
	Somewhat Weak	153 (10.5%)	158 (10.4%)	311 (10.4%)	
	Average	333 (22.7%)	383 (25.1%)	716 (24.0%)	
	Somewhat Strong	549 (37.5%)	616 (40.4%)	1165 (39.0%)	
	Very Strong	375 (25.6%)	335 (22.0%)	710 (23.8%)	
Comprehension	Very Weak	180 (12.3%)	119 ( 7.8%)	299 (10.0%)	<0.001
	Somewhat Weak	446 (30.5%)	458 (30.1%)	904 (30.3%)	
	Average	520 (35.5%)	544 (35.7%)	1064 (35.6%)	
	Somewhat Strong	237 (16.2%)	307 (20.2%)	544 (18.2%)	
	Very Strong	81 ( 5.5%)	95 ( 6.2%)	176 ( 5.9%)	
<b>ENGLISH</b>					
Reading words	Very Weak	234 (16.0%)	178 (11.7%)	412 (13.8%)	0.191
	Somewhat Weak	292 (19.9%)	297 (19.5%)	589 (19.7%)	
	Average	391 (26.7%)	492 (32.3%)	883 (29.6%)	
	Somewhat Strong	282 (19.3%)	312 (20.5%)	594 (19.9%)	
	Very Strong	265 (18.1%)	244 (16.0%)	509 (17.0%)	
Pronunciation	Very Weak	190 (13.0%)	178 (11.7%)	368 (12.3%)	0.046
	Somewhat Weak	311 (21.2%)	382 (25.1%)	693 (23.2%)	
	Average	506 (34.6%)	568 (37.3%)	1074 (36.0%)	
	Somewhat Strong	293 (20.0%)	252 (16.5%)	545 (18.2%)	
	Very Strong	164 (11.2%)	143 ( 9.4%)	307 (10.3%)	
Comprehension	Very Weak	297 (20.3%)	261 (17.1%)	558 (18.7%)	0.261
	Somewhat Weak	382 (26.1%)	430 (28.2%)	812 (27.2%)	
	Average	427 (29.2%)	446 (29.3%)	873 (29.2%)	
	Somewhat Strong	214 (14.6%)	237 (15.6%)	451 (15.1%)	
	Very Strong	144 ( 9.8%)	149 ( 9.8%)	293 ( 9.8%)	

<sup>a</sup>Cochran-Armitage test.**Table 2.** The sum of literacy “weakness” responses for KOKUGO and ENGLISH by gender.

	Sum of weakness	Gender		Total	P <sup>a</sup>
		Male	Female		
KOKUGO	0	1264 (86.3%)	1388 (91.1%)	2652 (88.8%)	<0.001
	1	155 (10.6%)	118 (7.7%)	273 (9.1%)	
	2	27 (1.8%)	9 (0.6%)	36 (1.2%)	
	3	18 (1.2%)	8 (0.5%)	26 (0.9%)	
ENGLISH	0	1104 (75.4%)	1186 (77.9%)	2290 (76.5%)	0.009
	1	133 (9.1%)	153 (10.0%)	286 (9.6%)	
	2	93 (6.4%)	88 (5.8%)	181 (6.1%)	
	3	134 (9.2%)	96 (6.3%)	230 (7.7%)	

<sup>a</sup>Cochran-Armitage test.

(GHQ scores). Adolescents who perceived themselves as very weak in KOKUGO showed significantly higher SDQ inattention and hyperactivity mean scores and significantly higher GHQ-12 scores.

Table 4 shows the literacy in ENGLISH, associated inattention and hyperactivity scores, and mental health charac-

teristics. As was for KOKUGO, adolescents who perceived themselves as very weak in ENGLISH showed significantly higher SDQ inattention and hyperactivity mean scores and significantly higher GHQ-12 scores.

Table 5 shows the results of the logistic regression analyses of possible predictors of the perception of very weak literacy

**Table 3.** “Have very weak areas” contrasted with “Do not have very weak areas” responses for KOKUGO literacy by Strengths and Difficulties Questionnaire and General Health Questionnaire scores.

			N	Mean	SD	P <sup>a</sup>
Whole						
SDQ	Inattention	HAVEs <sup>b</sup>	311	2.46	1.10	
		HAVE-NOTs <sup>c</sup>	2551	1.95	1.10	<0.001
	Hyperactive	HAVEs	312	3.00	1.32	
		HAVE-NOTs	2554	2.25	1.32	<0.001
GHQ-12	HAVEs	324	3.87	3.17		
	HAVE-NOTs	2589	2.84	2.79	<0.001	
Male						
SDQ	Inattention	HAVEs	182	2.46	1.15	
		HAVE-NOTs	1215	1.95	1.10	<0.001
	Hyperactive	HAVEs	181	2.92	1.23	
		HAVE-NOTs	1213	2.36	1.34	<0.001
GHQ-12	HAVEs	192	3.48	3.31		
	HAVE-NOTs	1233	2.40	2.62	<0.001	
Female						
SDQ	Inattention	HAVEs	129	2.46	1.15	
		HAVE-NOTs	1336	1.95	1.10	<0.001
	Hyperactive	HAVEs	131	3.11	1.42	
		HAVE-NOTs	1341	2.15	1.29	<0.001
GHQ Total	HAVEs	132	4.44	2.86		
	HAVE-NOTs	1356	3.23	2.87	<0.001	

SD, standard deviation; SDQ, Strengths and Difficulties Questionnaire; GHQ-12, General Health Questionnaire (12 items).

<sup>a</sup>Mann–Whitney U test.<sup>b</sup>Have very weak areas for KOKUGO literacy<sup>c</sup>Do not have very weak areas for KOKUGO literacy**Table 4.** “Have very weak areas” contrasted with “Do not have very weak areas” responses for ENGLISH literacy by Strengths and Difficulties Questionnaire and General Health Questionnaire scores.

			N	Mean	SD	P <sup>a</sup>
Whole						
SDQ	Inattention	HAVEs <sup>b</sup>	653	2.43	1.10	
		HAVE-NOTs <sup>c</sup>	2209	1.88	1.08	<0.001
	Hyperactive	HAVEs	653	2.82	1.32	
		HAVE-NOTs	2213	2.18	1.31	<0.001
GHQ-12	HAVEs	676	3.91	3.23		
	HAVE-NOTs	2237	2.66	2.66	<0.001	
Male						
SDQ	Inattention	HAVEs	335	2.41	1.10	
		HAVE-NOTs	1062	1.89	1.08	<0.001
	Hyperactive	HAVEs	330	2.86	1.31	
		HAVE-NOTs	1064	2.30	1.32	<0.001
GHQ-12	HAVEs	349	3.51	3.19		
	HAVE-NOTs	1076	2.23	2.51	<0.001	
Female						
SDQ	Inattention	HAVEs	318	2.45	1.09	
		HAVE-NOTs	1147	1.87	1.09	<0.001
	Hyperactive	HAVEs	323	2.77	1.34	
		HAVE-NOTs	1149	2.08	1.29	<0.001
GHQ Total	HAVEs	327	4.34	3.21		
	HAVE-NOTs	1161	3.06	2.73	<0.001	

SD, standard deviation; SDQ, Strengths and Difficulties Questionnaire; GHQ-12, General Health Questionnaire (12 items).

<sup>a</sup>Mann–Whitney U test.<sup>b</sup>Have very weak areas for ENGLISH literacy<sup>c</sup>Do not have very weak areas for ENGLISH literacy

for KOKUGO. Boys perceived more weakness for KOKUGO than girls, but there was no significant difference between boys and girls for grade level score. For boys, the scores for inattention ( $p = 0.001$ ), hyperactivity ( $p = 0.020$ ), and GHQ ( $p = 0.002$ ) were significantly related to perceived reading weaknesses but grade level ( $p = 0.485$ ) did not show any significant difference. For girls, the scores for hyperactivity ( $p < 0.001$ ), and GHQ ( $p = 0.018$ ) were significantly related to perceived reading weaknesses, but scores for inattention

( $p = 0.341$ ) and grade level ( $p = 0.222$ ) were not.

Table 6 shows that the scores for inattention, hyperactivity, and GHQ total were significantly related to ENGLISH literacy. The score for gender ( $p = 0.068$ ) was not significantly related to literacy, but the score for grade level was, suggesting that students at higher grades were more likely to perceive weaknesses in ENGLISH literacy. For both genders, all the variables of inattention, hyperactivity, GHQ, and grade level were significant.

**Table 5.** Logistic regression analysis of “Very weak” responses for KOKUGO literacy by inattention, hyperactivity, and General Health Questionnaire total scores.

Variables	Regression Coefficient	Standard Error	P	Cox-Snell R <sup>2</sup>
Whole				
Inattention	0.208	0.064	0.001	
Hyperactivity	0.280	0.051	<0.001	
GHQ Total Scores	0.082	0.021	<0.001	
Grade Level	-0.033	0.078	0.668	
Gender (0=male, 1=female)	-0.453	0.129	<0.001	0.042
Male				
Inattention	0.283	0.084	0.001	
Hyperactivity	0.157	0.068	0.020	
GHQ Total Scores	0.087	0.028	0.002	
Grade Level	0.072	0.103	0.485	0.037
Female				
Inattention	0.094	0.099	0.341	
Hyperactivity	0.440	0.080	<0.001	
GHQ Total Scores	0.078	0.033	0.018	
Grade Level	-0.147	0.120	0.222	0.046

GHQ, General Health Questionnaire.

**Table 6.** Logistic regression analysis of “Very weak” responses for ENGLISH literacy by inattention, hyperactivity, and General Health Questionnaire total scores.

Variables	Regression Coefficient	Standard Error	P	Cox-Snell R <sup>2</sup>
Whole				
Inattention	0.280	0.048	<0.001	
Hyperactivity	0.199	0.039	<0.001	
GHQ Total Scores	0.105	0.017	<0.001	
Grade Level	0.280	0.059	<0.001	
Gender (0=male, 1=female)	-0.176	0.097	0.068	0.078
Male				
Inattention	0.292	0.068	<0.001	
Hyperactivity	0.150	0.055	0.006	
GHQ Total Scores	0.118	0.024	<0.001	
Grade Level	0.337	0.084	<0.001	0.087
Female				
Inattention	0.267	0.069	<0.001	
Hyperactivity	0.245	0.056	<0.001	
GHQ Total Scores	0.094	0.023	<0.001	
Grade Level	0.232	0.084	0.006	0.076

GHQ, General Health Questionnaire.

## Discussion

The purposes of the present study were to examine literacy weakness for KOKUGO and ENGLISH in Japanese adolescents and to investigate the relationships between literacy weakness and inattention and hyperactivity characteristics. Perceived literacy weakness was higher for ENGLISH than for KOKUGO, and boys had more weak areas than girls for both languages. The bivariate analyses and the logistic regression analyses revealed that inattention and hyperactivity characteristics, together with mental health status, were associated with literacy weakness for both languages.

Gender was significantly associated with the perception of very weak KOKUGO literacy and grade level was significantly associated with weakness in ENGLISH. This may be because boys experience prolonged neurological development during puberty.<sup>24</sup> As Koolschijn et al. have discussed, there are sex and age differences in development of the four lobar areas.<sup>25</sup> Boys aged between 8 and 15 years show a larger lobar surface area than girls, indicating that boys have a prolonged, if not slower, surface area expansion whereas that of girls matures earlier.<sup>25</sup> Our results confirmed the previous reports.

Our results provided a significant relationship between inattention/hyperactivity and reading literacy for ENGLISH in a Japanese context. The results suggest that the relationship between inattention/hyperactivity and reading weakness is significant regardless of language or gender. For boys, the relationship between both inattention and hyperactivity and KOKUGO literacy was significant. For girls, the language made a difference: the relationship between hyperactivity and KOKUGO literacy was significant, but that between inattention and KOKUGO was not. In contrast, the relationship between perceived ENGLISH reading weaknesses and both inattention and hyperactivity were significant for girls.

We identified a significant association between GHQ and reading weakness. This suggests a possible relationship between reading weakness and mental health or ADHD; as Carroll et al. have reported, there may be comorbidity between reading weakness and symptoms such as depressive mood, anxiety, or low self-esteem.<sup>9</sup> Thus, high GHQ scores might suggest various comorbidities between inattention or hyperactivity features and reading literacy challenges. It should be noted, however, that the present results are not evidence for causality between the two factors, as this was a correlational study.

We did not find a significant association between grade level and KOKUGO literacy; however, there was a significant association between grade level and ENGLISH literacy,

regardless of gender. One possible reason for this difference between the two languages may be that, as ENGLISH is a foreign language, students in higher grades perceive a greater literacy weakness. As KOKUGO is the native language, students perceive less literacy weakness, perhaps because of its familiarity, even though the complexity of the KOKUGO curriculum increases in higher grades (as does the ENGLISH curriculum). Furthermore, ENGLISH is a language that is built on phonemes and letters as symbols, whereas Japanese is the native language that is built on two phonetic syllabaries (hiragana and katakana), and visual and phonetic logographic kanji. This means that, when required to read Japanese sentences with efficiency, Japanese readers must use pathways similar to those of Chinese readers when reading kanji. When reading hiragana, which is a phonetic writing system, the pathways are much similar to those of alphabet readers.<sup>26</sup> This means that Japanese adolescents must be able to use different orthographies to read and comprehend Japanese sentences. Another reason why performance on the two languages may differ relates to the encoding of ENGLISH. Kuhl et al. postulate that Japanese infants' discrimination of ENGLISH "r-l sounds" declines between 8 and 10 months of age, suggesting that the critical period theory has some validity.<sup>27</sup> Our findings support this critical period theory. However, Durgunoglu argues against this theory by noting that Turkish children's phonological awareness and decoding develop rapidly because of the transparent orthography and the special characteristics of phonology and morphology.<sup>28</sup> However, reading comprehension is still a problem for Turkish children.<sup>28</sup> Thus, in transparent languages, mastery of spelling-sound knowledge is less predictive of the development of true reading skill and associated with smaller individual differences because the task is easier.<sup>29</sup>

The Organization for Economic Cooperation and Development's Center for Educational Reform and Innovation has reported that English children learn to read more slowly than their European counterparts, but this difference disappears by the age of 12 years.<sup>30</sup> A study in Wales<sup>31</sup> pointed out that a transparent orthography does not confer any advantages as far as reading comprehension is concerned. Our findings are consistent with this notion. Adolescents in Finland are consistently among the top performers in English reading comprehension ability.<sup>16</sup> English education in Finland is offered at the age of 6 years, or preschool age<sup>32</sup>, suggesting that Finnish infants acquire very early a universal ability to distinguish the non-transparent phoneme-grapheme systems of ENGLISH. Thus, we hypothesize that the Finnish language education system is designed to address the critical period theory with early education. Why, then, has Japan's perfor-



mance in ENGLISH reading ability been one of the worst? At the present time, we can only hypothesize that this weakness is attributable to how ENGLISH is taught in Japan.

### Limitations and future directions

The present findings should be interpreted in the light of several limitations that hinder their generalizability. First, the cross-sectional design does not permit a causal interpretation of the relationships identified. In terms of information biases, this was a self-report survey and some students might not have given genuine answers to the questionnaire items or might have exaggerated their strengths or weaknesses. As nearly 90% of the adolescent students who participated provided valid answers, it is unlikely that there was much selection bias, but it is possible that the sampling missed some students who had been absent from school for a long time or been shut-ins for some reasons. Regarding confounding bias, we have not included all the factors that might influence students' perception of their strengths and weaknesses in the subject areas, such as parents' educational background and income levels, hereditary factors, or even students' original nationalities. Future studies are needed to compare these groups on clinical and psychopathological measures to ascertain the ADHD and dyslexia-specific markers that might relate to these factors in a Japanese context.

### Conclusion

We identified statistically significant relationships between inattention and hyperactivity and reading literacy independent of gender or language. There were also significant relationships between mental health characteristics and reading literacy that suggest possible comorbidities. Grade level predicted reading weaknesses only for ENGLISH, for both genders. How ENGLISH is taught and how the critical period for learning ENGLISH is handled may play a key role in overcoming English reading literacy difficulties in Japanese adolescents.

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