Emotional Awareness and Cognitive Performance in Borderline Intellectual Functioning Young Adolescents

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Abstract: According to *DSM-5* and *ICD-10*, borderline intellectual functioning (BIF) should not be classified properly as a disorder. However, BIF people may present relevant problems of adaptive functioning in several areas of daily activities, and they seem to be more vulnerable to mental diseases. Young adolescence may be considered a particular period for emotional information processing. The "own and others' emotions" awareness can play a crucial role in many daily life situations, such as decision making, interpersonal relationships, and decoding of facial expressions. On this background, a BIF young adolescents group underwent a neuropsychological assessment including emotional and cognitive domains, and was compared with a healthy young adolescents control group (HC). In the overall sample, a significant negative correlation between general intellectual abilities and emotional awareness was found. The BIF group showed a significantly greater level of alexithymia and a poorer performance in higher cognitive tasks than HC group. As hypothesized, a border cognitive functioning influences mentalization processes as ability to discriminate and monitor emotions, as well as higher domains of cognition.

Key Words: Emotional awareness, borderline intellectual functioning, cognitive performance, young adolescents

(*J Nerv Ment Dis* 2019;207: 365–370)

Borderline intellectual functioning (BIF) has always been a complex diagnostic construct (Wieland and Zitman, 2016), which includes people with border cognitive level between normal intellectual functioning and cognitive disability. In the BIF classification criteria, the *DSM* (American Psychiatric Association, 1952) defined as "mild mental deficiency" an IQ score of 1 or 2 standard deviations below the mean, associated with cultural, physical, and emotional impairments. In *DSM-3* (American Psychiatric Association, 1980), BIF became a V-code used to indicate other conditions that may be a focus of clinical attention (relational, occupational, or phase of life problems). For over 30 years, the BIF classification has not changed and the *DSM-3*, *DSM-4*, and *DSM-4-TR* have used the previously assigned V-code (American Psychiatric Association, 1980, 1993, 2000). In the *DSM-5* (American Psychiatric Association, 2013), the IQ boundaries from the diagnostic classification of the BIF have been removed, apparently with no criteria provided to exactly define the BIF. However, although according to the *DSM-5* and *ICD-10* (World Health Organization, 2010), BIF should not be classified as a disorder, and despite receiving little attention in research, BIF people appear as a vulnerable group from an early age (Wieland and Zitman, 2016).

Several studies have documented that mothers of BIF children, compared with parents of children with normal IQ, showed poor parenting, little positive involvement (Fenning et al., 2007), and higher stress levels (Precenzano et al., 2016). Moreover, adult BIF people may present relevant problems of adaptive functioning (Emerson, 2011), physical problems (Snell et al., 2009), poverty, and difficulties in several areas of daily life activities (Fujiura, 2003; Gigi et al., 2014; Hassiotis et al., 2008; Peltopuro et al., 2014). BIF adolescents seem to be more vulnerable to mental diseases, such as posttraumatic stress disorder, substance misuse/abuse, and personality disorder, than adolescents with normal range IQ scores (Chen et al., 2006; Didden et al., 2009; Emerson, 2011; Emerson et al., 2010; Hassiotis et al., 2008; Hassiotis et al., 2011; Wieland et al., 2014; Wieland et al., 2015; Zammit et al., 2004). Moreover, BIF has been identified as relevant risk factor for suicide among preadolescents and adults (Hassiotis et al., 2011; Weiner and Pfeffer, 1986).

Recently, several theoretical and clinical studies have shown significant correlations between cognition and emotion in healthy and clinical populations (Onor et al., 2010; Smirni et al., 2018a). A negative correlation between cognitive functioning and difficulty in identifying and describing emotions (classified by Sifneos as "alexithymia" or "no words for emotions"; Sifneos, 1972) was found in patients with panic disorder in American veterans (Lamberty and Holt, 1995) and in healthy volunteers (Paradiso et al., 2008). Likewise, alexithymia was associated with poorer performance on several cognitive domains in a sample of Italian adults (Onor et al., 2010) and among asymptomatic HIV-positive participants (Bogdanova et al., 2009). Smirni and colleagues showed, in mild Alzheimer disease and mild cognitive impairment patients, higher level of alexithymia associated with impairments in specific cognitive domains, including long-term verbal memory (Smirni et al., 2018a). Similarly, Benbrika et al. (2018) found a high level of alexithymia associated with impairment of executive functions and verbal fluency tasks in amyotrophic lateral sclerosis.

In the 1970s, Premack and Woodruff worked out the theory construct known as Theory of Mind (ToM; Premack and Woodruff, 1978; Stone et al., 1998). Such a complex ability appears as a multidimensional construct that involves a large neural network (Adenzato and Poletti, 2013) and at least two different systems (Brothers and Ring, 1992). The first system, mainly cognitive, allows to recognize others' thinking, beliefs, and intentions, and the second, mainly affective, is involved in processing other's emotions and feelings (Shamay-Tsoory et al., 2009). Prefrontal cortex, right orbitofrontal cortex, left medial frontal cortex, precuneus, posterior superior temporal sulci, and temporoparietal junction appear to be active during ToM tasks (Abu Akel and Shamay-Tsoory, 2011; Adenzato and Poletti, 2013; Bara et al., 2011; Enrici et al., 2011; Lee et al., 2010; Roca et al., 2011). The ventromedial prefrontal cortex seems to play a key role in affective domain (Gupta et al., 2012), whereas the dorsolateral is crucial in cognitive domain (Kalbe et al., 2010; Sebastian et al., 2012). In a lesion study, Xi et al. (2011) showed that ventrolateral impaired patients found more difficulties in the affective domain, whereas dorsolateral patients found

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ISSN: 0022-3018/19/20705–0365

DOI: 10.1097/NMD.0000000000000972

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more difficulties in the cognitive domain. In addition, the lack of recognition of emotions is a main feature of autism spectrum disorders (Stone et al., 1998). Similarly, such behavioral impairments were also found in many neurodegenerative pathologies (Poletti et al., 2012).

In the 1990s, an "emotional intelligence" (EI) construct was developed and identified as the ability to perceive emotions in oneself and others, to use emotions to facilitate thinking, to understand emotional meanings, and to manage emotions (Mayer et al., 2008). According to the EI construct, people with a better understanding and management of their own and others' emotions present a greater social adjustment (Brackett et al., 2011; Mayer et al., 2008). Furthermore, Barbey and colleagues, in a large sample of focal brain injured individuals, found "that emotional and psychometric intelligence recruit shared neural systems for the integration of cognitive, social, and affective processes" (Barbey et al., 2014). Overall, the three models using the psychopathological construct of alexithymia, the ToM, or the EI may support the hypothesis of a relationship between cognitive and emotional abilities.

Young adolescence is a developmental stage with an increased demand for autonomously regulated emotions and behavior (Steinberg, 2005). Maturational brain processes in the early adolescence involve brain regions crucial for different aspects of executive functioning, such as coordination of affect, behavior, and cognition (Keating, 2004), and for the mastery of most prefrontal tasks (Alkonyi et al., 2011; Gogtay et al., 2004; Ouyang et al., 2016; Steinberg, 2005). Early adolescence, therefore, may be regarded as a particular period for social and emotional information processing. The "own and others' emotions" recognition can play a key role in decision making, in interpersonal relationships, and in the decoding of facial expressions or emotional prosodic aspects of language. Moreover, many adolescent behaviors, such as looking for excessive feelings and risky or reckless behaviors, can derive from emotional needs such as the desire to maintain peer esteem.

On this background, the current study aimed to investigate relationship between general intellectual abilities and emotional awareness in a group of BIF young adolescents, compared with typical developing adolescents. The hypothesis was that the border cognitive condition could be associated to difficulties in emotional information processing. Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003) and Alexithymia Questionnaire for Children (AQC; Di Trani et al., 2009; Puente et al., 2016; Rieffe et al., 2006; Yearwood et al., 2017) were used to assess, respectively, general cognitive functionality and emotional awareness. In addition, a battery of standard neuropsychological tests was administered for the assessment of attention, learning and verbal memory, executive functions, and speed processing. For further detail concerning standardization, reliability, and validity of the tests, see Campo and Morales, 2003; Cohen et al., 1999; Crawford et al., 2010; Di Trani et al., 2009; Gray, 2003; Lewandowski, 1984; Mesulam, 2000; Mottram and Donders, 2005; Orsini, 1994.

METHODS

Participants

One hundred sixteen young adolescents, age ranged between 12.6 and 13.4 years, participated in the study (58 males, 58 females; average age, 12.9 ± 1.01). All participants were white, Italian speakers, and in middle socioeconomic status, and they were recruited in two Italian regions, Campania and Sicily. Participants were subdivided into two independent groups: experimental group, including 65 BIF adolescents (35 boys, 30 girls; mean age, 12.81 ± 1.05), from now on called BIF group; and controls of healthy comparison group, including 51 participants (23 boys, 28 girls; mean age, 12.59 ± 1.12), from now on called HC group.

Diagnoses of BIF were made by a trained research assistant, with neuropsychological or neuropsychiatric supervision (D.S., M.C.), using the WISC-IV criteria (full IQ score between 71 and 84). HC participants were classified as normal intellectual functioning, using the WISC-IV criteria (full IQ score between 85 and 115).

Exclusion criteria were WISC-IV full IQ score less than 71 or greater than 115, genetic syndromes (*i.e.*, Down, Prader-Willi, fragile X syndrome), endocrinological discharges (hypothyroidism), neurological (epilepsy, neuromuscular disease), and psychiatric disorders (autism, attention deficit hyperactive disorder, psychosis, depression, anxiety). Parents gave a written informed consent. The study was carried out according to the Ethical Principles for Medical Research Involving Human Subjects of the Declaration of Helsinki (2008).

Measures

Emotional awareness was computed using the AQC (Di Trani et al., 2009; Puente et al., 2016; Rieffe et al., 2006; Yearwood et al., 2017) consistent with the original adult questionnaire TAS-20 (Bagby et al., 1994). The questionnaire identified three factors: a) difficulty identifying feelings (DIF), b) difficulty describing feelings (DDF), c) externally oriented thinking (EOT). Participants were asked to score each item on a three-point scale (0 = not true; 1 = a bit true; 2 = true). Maximum score was 40. The higher the score, the lower the emotional awareness.

Attentive performance was assessed using Benton Visual Form Discrimination Test (VFDT; Benton et al., 1983, 1994). VFDT consists of 16 multiple-choice items. A target set of three geometric figures, two majors and one small peripheral, must be analyzed and matched with four similar sets of three geometric figures. Participants were asked to identify the set identical to the target. Maximum score was 32. The test was administered according to the procedure described by Smirni et al. (2018b).

Memory was measured using digit span forward (Monaco et al., 2013; Orsini et al., 1987), Corsi block-tapping test forward (Lezak, 2004), and California Verbal Learning Test (CVLT; Delis et al., 2000). On the digit span and block-tapping test, participants required repeating strings of numbers or blocks of increasing length. The total score was the longest sequence of digits or blocks the participant was able to repeat. CVLT provided the following verbal memory parameters: words learned in the five learning trials (of 80), words recalled in short-term and in the long-term memory, and words recognized (of 16). Furthermore, clustering strategies were computed.

Executive functions and working memory were recorded using phonemic fluency test (Benton and Hamsher, 1989; Smirni et al., 2017), digit span backward, and Corsi block-tapping test backward. Phonemic fluency test requires the generation of words, starting with a given letter, in a given time frame. Total score on phonemic fluency was the total number of words produced. In the backward of the digit

TABLE 1. Correlations Between AQC Scores and IQ Scores in the Overall Sample

	Verbal IQ	Performance IQ	Full IQ
Task	*r*	*r*	*r*
AQC total	−0.86	−0.80	−0.93
DIF	−0.87	−0.79	−0.88
DDF	−0.83	−0.74	−0.93
EOT	−0.72	−0.72	−0.83

All correlations are significant $p < 0.0001$.
r indicates Pearson's correlations.

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TABLE 2. Average Scores, Standard Deviations, and *t*-Test of the BIF and HC Groups in the AQC and Its Subscales

Scale	BIF, Mean (SD)	HC, Mean (SD)	(*df*) *t*	*p*
DIF	10.63 (2.01)	4.37 (2.57)	(114) 14.85	<0.0001
DDF	8.12 (1.22)	4.21 (2.43)	(114) 11.40	<0.0001
EOT	9.41 (2.52)	4.86 (3.01)	(114) 8.94	<0.0001
AQC total	28.17 (4.66)	13.45 (7.51)	(114) 13.05	<0.0001

span and block-tapping tests, participants were asked to recall strings of numbers or blocks of increasing length in reverse order. The total score was the longest sequence of reversed digits or blocks the participant was able to recall.

Speed processing was computed using the digit symbol-coding (Lezak, 2004) and two verbal and nonverbal target cancellation tasks (Mesulam, 2000). Participants had to fill in an empty square with the symbol paired to the number. The score was the number of squares filled in correctly in 1 minute. The two cancellation tasks consisted of structured arrays of verbal and nonverbal stimuli. Participants were asked to circle all the targets they can find. The score was the number of the targets circled in 1 minute in each test.

Statistical Analysis

Data were analyzed using the independent samples *t*-test to examine whether there were significant differences between groups in the demographic (*i.e.*, age), emotional (*i.e.*, alexithymia), and cognitive variables (*i.e.*, attention, memory, executive functions, speed processing). Independent samples chi-square analysis was conducted to examine sex differences between the two groups. Correlations between emotional awareness and cognitive variables, using the Pearson's coefficient, were computed. A p value less than 0.05 was considered statistically significant for all analyses. All data were coded and analyzed using the commercially available STATISTICA 8.0 package for Windows (StatSoft, Inc, Tulsa, OK).

RESULTS

The BIF and HC groups were homogeneous for both age and sex factors (age: $t[114] = 1.09$, $p = 0.28$; sex: $\chi^2[1] = 0.87$, $p = 0.35$).

In the overall sample, correlational analyses showed high and negative correlations between the AQC total score, DIF, DDF, EOT subscales, and the IQ scores (AQC total score *vs*. verbal IQ: $r = -0.86$, $p < 0.0001$; AQC total score *vs*. performance IQ: $r = -0.80$, $p < 0.0001$; AQC total score *vs*. full IQ: $r = -0.93$, $p < 0.0001$; DIF *vs*. verbal IQ: $r = -0.87$, $p < 0.0001$; DIF *vs*. performance IQ: $r = -0.79$, $p < 0.0001$; DIF *vs*. full IQ: $r = -0.88$, $p < 0.0001$; DDF *vs*. verbal IQ: $r = -0.83$, $p < 0.0001$; DDF *vs*. performance IQ: $r = -0.74$, $p < 0.0001$; DDF *vs*. full IQ: $r = -0.93$, $p < 0.0001$; EOT *vs*. verbal IQ: $r = -0.72$, $p < 0.0001$; EOT *vs*. performance IQ: $r = -0.72$, $p < 0.0001$; EOT *vs*. full IQ: $r = -0.83$, $p < 0.0001$; Table 1).

Among groups, mean scores analyses of AQC and its subscales showed a group effect. The BIF group reached a significantly higher rate of alexithymia in AQC total score ($t[114] = 13.05$, $p < 0.0001$), and in the three AQC subscales (DIF: $t[114] = 14.85$, $p < 0.0001$; DDF: $t[114] = 11.40$, $p < 0.0001$; EOT: $t[114] = 8.94$, $p < 0.0001$; Table 2). In cognitive domains, BIF group showed significantly poorer results in the total score of the VFDT ($t[114] = 8.02$, $p < 0.0001$). They also reached a number of peripheral errors significantly higher than normal peers ($t[114] = 9.09$, $p < 0.0001$; Table 3). The differences between groups were not significant, in the forward span tests, both verbal ($t[114] = 1.07$, $p = 0.29$) and nonverbal ($t[114] = 0.96$, $p = 0.34$; Table 3). The BIF group showed poorer performance in CVLT learning trials ($t[114] = 15.49$, $p < 0.0001$), in short-term ($t[114] = 10.55$, $p < 0.0001$), and long-term recall ($t[114] = 16.81$, $p < 0.0001$), as well as in the use of semantic clustering strategies ($t[114] = 27.58$, $p < 0.0001$; Table 3). The two groups did not show significant differences in the recognition trial ($t[114] = 0.55$, $p = 0.58$; Table 3). The two groups differed in all the executive and working memory tasks. In particular, BIF group showed significantly lower performance in phonemic fluency task ($t[114] = 11.31$, $p < 0.0001$), in digit span test backward ($t[114] = 10.27$, $p < 0.0001$), and in Corsi block-tapping test backward ($t[114] = 12.47$, $p < 0.0001$; Table 4). In the speed processing tasks, BIF group was significantly slower than HC in digit symbol-coding ($t[114] = 17.35$, $p < 0.0001$). No differences were found between groups in letter cancellation test ($t[114] = 1.85$, $p = 0.07$) and symbol cancellation test ($t[114] = 1.89$, $p = 0.06$; Table 4).

DISCUSSION

The current study aimed to investigate the emotional and cognitive abilities of a BIF adolescent group, compared with a normal peer group, hypothesizing that the lower the cognitive level, the greater the difficulty of processing emotional information.

As expected, IQ parameters negatively correlated with total AQC and its three factors scores. Therefore, a better intellectual functionality, as expressed by IQ scores, correlated with a better emotional functionality, as expressed by AQC indexes. These correlations between intellectual and emotional parameters agree with the most recent research that argues that emotional and cognitive intelligence seems to share a neuro-functional-anatomical network (Barbey et al., 2014). Each of the two dimensions contributes, with specific competences, to the integration of cognitive and affective processes (Barbey et al., 2014). In

TABLE 3. Average Scores, Standard Deviations, and *t*-Test of the BIF and HC Groups in Attention and Memory Tasks

Task	BIF, Mean (SD)	HC, Mean (SD)	(*df*) *t*	*p*
VFDT total	25.69 (1.33)	27.94 (1.71)	(114) 8.02	<0.0001
VFDT per. err.	4.12 (0.78)	2.37 (1.29)	(114) 9.09	<0.0001
Digit span forward	5.32 (0.50)	5.45 (0.78)	(114) 1.07	0.29
Corsi BTT forward	5.37 (0.60)	5.49 (0.76)	(114) 0.96	0.34
CVLT learning trials	40.33 (2.86)	50.57 (4.29)	(114) 15.49	<0.0001
CVLT STM recall	7.6 (1.25)	10.14 (1.36)	(114) 10.55	<0.0001
CVLT LTM recall	7.14 (0.86)	9.98 (0.97)	(114) 16.81	<0.0001
CVLT clustering	10.35 (1.91)	21.14 (2.34)	(114) 27.58	<0.0001
CVLT recognition	14.98 (0.51)	15.04 (0.66)	(114) 0.55	0.58

per. err. indicates peripheral errors; BTT, block-tapping test; STM, short-term memory; LTM, long-term memory.

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TABLE 4. Average Scores, Standard Deviations, and *t*-Test of the BIF and HC Groups in Executive Functions and Speed Processing Tasks

Task	BIF, Mean (SD)	HC, Mean (SD)	(*df*) *t*	*p*
Phonemic fluency	21.46 (2.14)	26.1 (2.3)	(114) 11.31	<0.0001
Digit span backward	2.78 (0.48)	4.23 (1.01)	(114) 10.27	<0.0001
Corsi BTT backward	3.25 (0.50)	4.59 (0.67)	(114) 12.47	<0.0001
Digit symbol	21.73 (2.40)	31.25 (3.55)	(114) 17.35	<0.0001
Verbal cancellation	28.18 (1.43)	29.02 (3.26)	(114) 1.85	0.07
Nonverbal cancellation	29.52 (1.24)	29.96 (1.25)	(114) 1.89	0.06

BTT indicates block-tapping test.

neurorehabilitation, this could mean that cognitive enhancement could encourage an enrichment of emotional abilities. Especially because it has been hypothesized that the rate of learning improvement is strongly influenced by the emotional and motivational dimensions (Cattell, 1987).

Comparing the two groups, the BIF group showed greater difficulties in emotional awareness, with significantly higher scores both in the total AQC and in its three factors. It would seem that young BIF adolescents are not able to fully understand the high level of abstract mentalization, because of their concrete thought (Luyten and Fonagy, 2015; Luyten et al., 2012). Emotions appear as a subjective adaptive response to the events that find in the body the theater for their occurrence (Damasio, 1999). Identifying emotions using a proper label to name and differentiate them involves the transition from immediate "feel" of "something that happens in the body" to a higher-level cognitive response (Mesulam, 2000). However, awareness of emotions and accessibility to explicit consciousness are not automatic responses to autonomic changes (Delacour, 1997). Therefore, the somatoperceptive signals may not sufficiently processed to be identified as somatic expressions of emotions. As a result, thought appears externally oriented and focused on the concrete dimension of events. Cognition and emotion mutually influence each other. However, in BIF young adolescents, this influence could be ineffective because of border intellectual and emotional abilities.

In the current study, in BIF adolescents, no impairment has been detected in basic cognitive performance, instead the highest cognitive domains were compromised. In memory domain, for example, the two groups did not show significant differences in the simplest memory tasks (short-term memory and recognition). Instead, BIF group showed poorer performances in learning trials, in short- and long-term recall, and in clustering strategies (tasks requiring more active information's processing). Similarly, in higher cognitive domains, such as executive functions and working memory, the control group performed significantly better than BIF. It is widely known that digit or block span backward is a task implying more active maintenance and working memory abilities than digit or block span forward (Risberg and Ingvar, 1973). Likewise, phonemic fluency involves higher executive control such as lexical-phonological recall strategies, lexical production speed, flexibility, interference inhibition, and working memory. Furthermore, BIF group achieved a greater number of peripheral errors in the VFDT. Peripheral error expresses poor visual scanning, and difficulty in maintenance and sustained attention. This last finding agrees with previous research that has documented difficulties in the attentive maintenance in preschool children (Smirni et al., 2018c). Similarly, in speed processing tasks, no differences were found between groups on letter and symbol cancellation tests, where the participants were asked to circle the target structured in ordered arrays. In the digit symbol-coding task, instead, BIF group performance was significantly poorer than HC. The task, in fact, required not only response speed, visuomotor coordination, and motor persistence but also higher cognitive processing, such as incidental memory, complex scanning, selective and sustained attention, and perceptual organization (Lezak, 2004).

Some caveats need to be acknowledged. The first limitation of the study was the limited age group studied. Further research including measurement of a more extended age group population should investigate interactions between emotional and cognitive processing. Second limit was to have used only a 20 items questionnaire (AQC) to measure emotional awareness. No large claims can be supported by a single questionnaire, even if significant correlations have been highlighted. The conclusions concerning the correlations observed, however, must be cautiously interpreted because causality is not warranted. Third limit was the difficulty of controlling interference from familiar and environmental variables. The participants studied came from a similar socioeconomic status; however, further research in different sociocultural contexts would be needed.

In sum, as expected, the BIF group performed worse than normal peers in more integrated attentive, memory, executive, and speed processing tasks, and showed lower emotional awareness. The border cognitive functioning influences both the higher aspects of cognition and mentalization processes. A similar relationship, between general intellectual abilities and emotional awareness, was already observed in adults. Barbey and colleagues have reported that social and emotional functioning contributes to human cognitive abilities in addition to general intellectual capacities (Barbey et al., 2014). In addition, a lower emotional awareness can be a condition of risk for meaningful life outcomes. Many everyday life behaviors result from poorly defined or poorly understood emotions and can represent an uncontrolled "gut feelings" (Steinberg, 2005).

In clinical and rehabilitative practice, these data could be promising because they encourage specific cognitive-emotional treatment in young BIF adolescents to improve cognitive, social, and emotional abilities. Therefore, a better understanding of cognitive and emotional behaviors can stimulate a more appropriate evaluation of social situations of daily life and generally improve the quality of life.

DISCLOSURES

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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