Eötvös Loránd University
Faculty of Education and Psychology

THESES OF THE DOCTORAL DISSERTATION

EDINA SZABÓ

Callous-unemotional (CU) traits and their association with emotional processing

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INTRODUCTION[1]

In recent years, much attention has been paid to the emotional deficit described in psychopathy. More specifically, the affective features of psychopathic disorder (i.e., callous-unemotional or CU traits) have gained wide attention, which are believed to be the developmental precursor to adult psychopathy (Frick, 2009). CU traits include characteristics such as lack of guilt, limited empathy, and shallow affect, and they are considered to be the core features of psychopathy (Cleckley, 1941; Hart & Hare, 1996). With the release of the fifth revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), CU traits have been added as a specifier for conduct disorder ("with limited prosocial emotions") which supports the need for valid and reliable measurements of these traits.

The relationship between CU traits and externalizing/internalizing symptoms

Individuals with high levels of CU traits are more likely to show chronic and persistent antisocial behaviour (Leistico, Salekin, DeCoster, & Rogers, 2008). CU traits are related to severe externalizing symptoms in children and adolescents (in clinical, community, and forensic samples), and conduct problems have been found to be more highly heritable in the presence of CU traits (Viding, Blair, Moffitt, & Plomin, 2005). It should be also noted that youth with both CU traits and conduct problems show poorer outcomes to a variety of treatments (Frick, Ray, Thornton, & Kahn, 2014).

In addition, CU traits are related to proactive aggression (Bozsik et al., 2013; Marsee & Frick, 2007; Raine et al., 2006), although some evidence suggests that CU traits are associated with both proactive and reactive aggression (Eisenbarth, Demetriou, Kyranides, & Fanti, 2016; Fanti, Frick, & Georgiou, 2009). Whereas the proactive (instrumental) type is calculated and goal-directed, reactive (hostile) aggression is an impulsive response to a real or perceived provocation and has been linked to negative emotions (e.g., anger) (Dodge, 1991).

However, there are controversial findings regarding the relationship between attention-deficit/hyperactivity disorder (ADHD) and CU traits. According to Lynam's model (1996), it is the combination of childhood ADHD and conduct disorder which designates an important subgroup of antisocial youth for showing characteristics that are consistent with the description of adult psychopathy. Although this model has garnered some empirical support, other studies have reported that the development of core psychopathic features, such as deficits in emotional processing, is depend primarily on the level of conduct problems and not the level of ADHD symptoms (Michonski & Sharp, 2010; Smith & Hung, 2012).

The association between CU traits and internalizing symptoms is more complex. While some studies have shown that CU traits are liked to lower anxiety, depression and somatic symptoms (Essau, Sasagawa, & Frick, 2006), other research has found that psychopathic traits are associated with more internalizing problems (Moran, Ford, Butler, & Goodman, 2008) or there is no link between them (Viding, Simmonds, Petrides, & Frederickson, 2009). These contradictory findings might be explained by the two types of psychopathic disorder. There might be primary and secondary variants of CU traits, where the secondary variant is associated with higher anxiety, and shows a greater history of childhood abuse and trauma (Karpman, 1941; Porter, 1996). That is, the secondary type is more prone to negative emotionality (e.g., anxiety, depression), hostility and other symptoms of emotional distress (Docherty, Boxer,

[1] The Introduction is partly based on the following two publications:
Szabó, E., & Kökönyei, Gy. (2018). Az érzelmi feldolgozás vizsgálata a fiatalkori pszichopátiás vonások vonatkozásában: Áttekintő tanulmány. *Magyar Pszichológiai Szemle*, 73(2), 237–267.
Szabó, E., Galambos, A., Szabó, J., & Kökönyei, Gy. (2016). A pszichopátiás személyiségzavar altípusai: Elsődleges és másodlagos változat. *Alkalmazott Pszichológia*, 16(4), 49-70.

Huesmann, O'Brien, & Bushman, 2015; Kimonis, Frick, Cauffman, Goldweber, & Skeem, 2012).

CU traits and deficits in emotional processing

During the past few years, research on the nature of psychopathy has been dominated by theories that describe psychopathy as a developmental disorder and recognize deficient emotional experience as a hallmark of psychopathy (Bird & Viding, 2014; Blair, 2005). Several empirical studies have shown that youth with CU traits, like adult psychopaths, show difficulties in processing and recognizing emotional stimuli, especially negative emotions. It seems that they show reduced emotional response to others' distress (e.g., painful, fearful and sad expressions) which might lead to more aggression and violence (Blair, 2005).

Individuals with CU traits also show altered neural processing of emotional stimuli. Dysfunction of the amygdala is believed to be critical for deficits in processing distress cues. Consistent with the integrated emotion systems model (Blair, 2005), studies using functional magnetic resonance imaging (fMRI) have demonstrated that children and adults with CU traits show lower amygdala response to fearful expressions (Decety, Skelly, Yoder, & Kiehl, 2014; Dolan & Fullam, 2009; Jones, Laurens, Herba, Barker, & Viding, 2009; Viding et al., 2012).

According to Kiehl's neurobiological model (Kiehl, 2006), the anterior cingulate cortex (ACC) also contributes to the impairments observed in psychopathy. Reduced ACC activation has been reported in both children and adults with psychopathic traits during emotion related tasks such as affective memory (Kiehl et al., 2001), fear conditioning (Birbaumer et al., 2005), and viewing pictures of others in pain (Lockwood et al., 2013).

The majority of neuroimaging research has focused on clinical or incarcerated male samples. Thus, only limited information is available on the neural correlates of CU traits among noncriminal samples. However, in recent years, there has been a move toward viewing psychopathic traits as dimensions existing along a continuum. Several researchers have argued that individuals with psychopathic traits differ from other people in terms of degree (i.e., more or less psychopathic) and not in kind (i.e., psychopath / nonpsychopath) (Edens, Marcus, Lilienfeld, & Poythress, 2006; Herpers et al., 2017). In our studies, we applied this approach and measured CU traits as a dimensional construct.

AIMS OF THE STUDIES

The aim of our *first study* was to test the applicability and reliability of the self-report Inventory of Callous-Unemotional Traits (ICU; Frick, 2003; Pataky et al., 2011) in a high-risk sample of adolescent boys. The ICU is one of the most widely used measures of CU traits which can be applied across different samples (e.g., children and adults) and had a clear impact on the development of the "limited prosocial emotions" specifier in DSM-5. First, confirmatory factor analyses (CFA) were conducted to investigate the factor structure of the ICU. Second, we tested the convergent validity of the ICU scores by examining relationships with externalizing symptoms (including conduct problems, hyperactivity-inattention symptoms, proactive-reactive aggression), and prosocial behaviour.

In our *second study*, we tested the link between CU traits and attentional bias towards emotional stimuli among high-risk boys. Besides using self-report measures, attentional bias was tested by a picture-based dot-probe task. Our first aim was to investigate whether high levels of CU traits are related to reduced response to negative emotional stimuli. Second, we aimed to explore the moderating role of different behavioural and emotional problems in the relationship between CU traits and deficits in emotional processing. Research to date has mainly focused on the level of aggression (e.g., Kimonis, Frick, Muñoz, & Aucoin, 2008). The purpose of the present study was to replicate prior findings and to extend them by testing the potential moderating effects of conduct problems, hyperactivity-inattention and emotional symptoms.

Using a dimensional approach to CU traits, the aim of our *third study* was to investigate neural activity during performance of a facial expression recognition task in a community sample of young adults. In this study, functional MRI data were collected to measure neural responses to fearful, happy and sad faces as compared with neutral facial expressions. Again, CU traits were measured by the self-report ICU.

EMPIRICAL STUDIES

1. study: Psychometric properties of the Inventory of Callous-Unemotional Traits in a high-risk sample of adolescent boys

Our aim was to test the internal structure of the self-report ICU in a high-risk sample of adolescent boys. Different theoretical models proposed in previous studies were tested using CFA. In addition, MIMIC modelling (CFA with covariates) was applied to test the convergent validity of the ICU by including externalizing symptoms and prosocial behaviour as covariates and CU traits as latent variables.

We assumed that a three-factor latent structure would emerge with a general CU factor as well as with three subfactors (callousness, uncaring, unemotional), which was described in a previous study with high-risk adolescents (Kimonis, Frick, Skeem, et al., 2008) (*N* = 248, 188 boys). In addition, we hypothesized that CU traits would show positive associations with conduct problems, hyperactivity-inattention symptoms and aggression (especially the proactive form), and negative associations with prosocial behaviour (Bozsik et al., 2013; Lynam, 1996; Pataky et al., 2011; Raine et al., 2006).

1.1. Methods

1.1.1. Participants

Participants were 202 adolescent boys (mean age: 16.63 years; *SD* = 1.71) from institutional care facilities and juvenile detention centres in urban and rural areas of Hungary. Most of the participants (*n* = 149) were recruited from juvenile detention centres.

1.1.2. Measures

1.1.2.1. Inventory of Callous-Unemotional Traits (ICU; Frick, 2003; Pataky et al., 2011)

The Hungarian version of the ICU was made available to us by Dr. József Halász. The ICU includes 24 items that are rated on a 4-point Likert scale ranging from 0 (*not at all true*) to 3 (*definitely true*) and 12 items are reversed during scoring.

1.1.2.2. Strengths and Difficulties Questionnaire (SDQ; Birkás, Lakatos, Tóth, & Gervai, 2008; Goodman, 1997)

The self-report version of the SDQ was used. It consists of 25 items rated on a 3-point Likert scale ranging from 0 (*not true*) to 2 (*certainly true*) and comprises five subscales. Four of the subscales represent adjustment difficulties: emotional symptoms, conduct problems, hyperactivity-inattention, peer problems. The fifth subscale assesses the positive aspect of prosocial behaviour.

1.1.2.3. Reactive-Proactive Aggression Questionnaire (RPAQ; Bozsik et al., 2013; Raine et al., 2006)

The RPAQ was used to measure proactive and reactive aggression. It is a 23-item self-report questionnaire with a 3-point Likert scale ranging from 0 (*never*) to 2 (*often*).

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Eötvös Loránd University.

1.2. Main results

We observed that the bifactor model with three correlated specific factors (callousness, uncaring and unemotional) and one general CU traits factor provided the best fit to the data (χ^2 = 259,57; *df* =184; $p < 0{,}001$; CFI = 0,95; TLI = 0,94; RMSEA = 0,04). Similar to previous studies (Ciucci, Baroncelli, Franchi, Golmaryami, & Frick, 2013; Essau et al., 2006; Fanti et al., 2009; Kimonis, Frick, Skeem, et al., 2008), items 2 and 10 were excluded from the ICU due to poor factor loadings.

The 22-item ICU showed acceptable internal consistency based on Cronbach's alpha (α) and omega (ω) coefficients for the general CU traits factor (α = 0.81, ω = 0.87), and for the specific callousness (α = 0.76, ω = 0.85) and uncaring subscales (α = 0.79, ω = 0.86). However, low internal consistency was found for the unemotional subscale (α = 0.45, ω = 0.46).

Besides ICU, reactive and proactive aggression scales showed good internal consistency (α = 0.82 and 0.87). Furthermore, we found acceptable internal consistencies for conduct problems (α = 0.67), hyperactivity-inattention (α = 0.65) and prosocial behaviour (α = 0.71).

Correlations between the main study variables are shown in Table 1-1.

Table 1-1. *Correlations between the main study variables*

	1	2	3	4	5	6	7	8	9	10	11
1. Age											
2. CU traits	-0.14										
3. Callousness	-0.06	**0.77****									
4. Uncaring	-0.14	**0.84****	**0.41****								
5. Unemotional	-0.04	**0.51****	0.17*	**0.27****							
6. Conduct problems	-0.04	**0.51****	**0.53****	**0.44****	-0.03						
7. Hyperactivity -inattention	-0.01	**0.46****	**0.41****	**0.42****	0.08	**0.56****					
8. Prosocial behaviour	-0.01	**-0.61****	**-0.40****	**-0.58****	**-0.31****	**-0.33****	**-0.31****				
9. Reactive aggression	0,05	**0.29****	**0.39****	0.23**	-0.11	**0.62****	**0.41****	-0.14*			
10. Proactive aggression	-0.05	**0.57****	**0.66****	**0.44****	0.02	**0.69****	**0.43****	**-0.30****	**0.65****		
11. Reactive aggression residual	0.10	-0.06	-0.07	-0.02	-0.13	0.22**	0.18*	0.03	**0.74****	0	
12. Proactive aggression residual	-0.09	**0.47****	**0.55****	**0.33****	0.08	**0.35****	0.21**	**-0.26****	0	**0.74****	**-0.67****

Note. CU = callous-unemotional.
To examine reactive and proactive aggression independently, standardized residuals were created for each aggression subscale.
* $p < 0.05$; ** $p < 0.01$
Results that remained significant after Bonferroni correction are shown in bold ($p < 0{,}0008$).

In the next stage, MIMIC analysis was carried out to test the convergent validity of the ICU. We estimated the impact of SDQ and RPAQ scales on the latent ICU factors (Table 1-2).

Table 1-2. *MIMIC model results: Standardized regression coefficients (and standard errors) on the latent ICU factors*

	CU traits (general factor)	Callousness	Uncaring	Unemotional
Conduct problems	0.04	0.12**	0.03	-0.02
	(0.06)	(0.05)	(0.06)	(0.07)
Hyperactivity-inattention	0.02	0.11	0.14**	0.06
	(0.05)	(0.07)	(0.05)	(0.05)
Prosocial behaviour	-0.21**	-0.27**	-0.26**	-0.21**
	(0.06)	(0.07)	(0.06)	(0.06)
Reactive aggression	0.01	-0.05	0.02	-0.07
	(0.03)	(0.03)	(0.03)	(0.03)
Proactive aggression	0.02	0.22**	0.11**	0.01
	(0.03)	(0.04)	(0.03)	(0.03)

Note. MIMIC = Multiple indicators multiple causes; ICU = Inventory of Callous-Unemotional Traits; CU = callous-unemotional.
** $p < 0.01$

1.3. Discussion

This study was the first to test the psychometric properties of the self-report version of the Hungarian ICU (Pataky et al., 2011) in a high-risk sample of adolescent boys. The results provide support for the use of a general CU factor score and three subscales scores (callousness, uncaring and unemotional). The 22-item ICU showed good internal consistency. However, similar to previous studies, low internal consistency was found for the unemotional scale, which might be explained by the small number of items (n = 5) constituting this scale. It is also possible that the unemotional subscale does not sufficiently capture deficient emotional responses associated with CU traits (Viding & Kimonis, 2018).

In line with previous studies, CU traits showed positive associations with conduct problems, hyperactivity-inattention symptoms and proactive aggression (even after controlling for reactive aggression) (Bozsik et al., 2013; Marsee & Frick, 2007; Pataky et al., 2011; Viding et al., 2009). At subscale level, both the callousness and uncaring dimensions were related to externalizing symptoms, but unemotional subscale was not. Finally, the prosocial scale of the SDQ showed negative associations with CU traits and all subscales of the ICU. It should be noted that the unemotional scale was only related to lower prosocial behaviour. Consistent with past research, the unemotional subscale of the ICU seems to largely tap factors specifically related to lack of empathic concern and prosocial attitudes that are independent of antisocial behaviour (Ciucci et al., 2013; Kimonis, Frick, Skeem, et al., 2008; Pataky et al., 2011; Viding et al., 2009).

Our conclusion is that the Hungarian ICU is a reliable and valid measure of CU traits and can be used among high-risk adolescents. Our results support the associations between CU traits and externalizing problems and highlight the role of the different subscales. These findings can help to understand which aspects of CU traits (the callousness traits) can be linked to higher risk of developing aggressive and antisocial behaviour.

2. study: Callous-unemotional traits and the attentional bias towards emotional stimuli: Testing the moderating role of emotional and behavioural problems among high-risk adolescents[2]

The aim of our second study was to explore the moderating role of different externalizing and internalizing symptoms in the relationship between CU traits and attentional bias towards emotional stimuli. This study was also conducted in a high-risk sample of adolescent boys.[3] Attentional bias was tested by an affective dot-probe task (Kimonis, Frick, Muñoz, & Aucoin, 2007) which has become a reliable measure of emotional processing in the past few years.

We hypothesized that CU traits would be related to reduced attentional bias towards distress cues and we expected that this association would be moderated by the level of conduct problems, hyperactivity-inattention and emotional symptoms. That is, higher levels of conduct problems and hyperactivity-inattention symptoms, and lower levels of emotional problems would increase the negative impact of CU traits on attentional orienting to distress cues (Blair, 2005; Kimonis et al., 2012; Kimonis, Frick, Fazekas, & Loney, 2006; Kimonis, Frick, Muñoz, et al., 2008; Kimonis, Graham, & Cauffman, 2018; Lynam, 1996; Williams et al., 2008).

2.1. Methods

2.1.1. Participants

The sample consisted of 102 adolescent boys (mean age: 16.34 years, *SD* = 1.32). Thirty-four participants were recruited from institutional care facilities and 68 from juvenile detention centres.

2.1.2. Measures

2.1.2.1. Inventory of Callous-Unemotional Traits

In line with previous research and our own findings, items 2 and 10 were omitted from the ICU used in the present study. In the current high-risk sample, consistency measures were acceptable, with a Cronbach's α of 0.81 for the total scale, 0.77 for the callousness and 0.75 for the uncaring factor. The unemotional factor had marginal consistency (α = 0.40). For this reason, only the total score was used which was also supported by the first study.

2.1.2.2. Strengths and Difficulties Questionnaire

All the subscales demonstrated acceptable internal consistency in the current sample. The Cronbach's alpha was 0.71 for the total difficulties score, 0.63 for emotional symptoms, 0.63 for conduct problems, 0.65 for hyperactivity-inattention, 0.61 for peer problems and 0.74 for prosocial behaviour.

2.1.2.3. Emotional pictures dot-probe task (Kimonis et al., 2007)

The task measures attentional bias towards both positive and distressing stimuli. It was presented by using the Inquisit version 3.0.6.0 software (Millisecond Software, Seattle, WA). The stimuli used in the task consisted of images reflecting: distress (e.g., crying child), positive emotions (e.g., kittens), neutrality (e.g., a spoon). These images were taken from the International Affective Picture System (IAPS; Deák, 2011; Lang, Bradley, & Cuthbert, 1997).

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[2] The present chapter is based on the following publication: Szabó, E., Halász, J., Morgan, A., Demetrovics, Zs., & Kökönyei, Gy. (2019). Callous-unemotional traits and the attentional bias towards emotional stimuli: Testing the moderating role of emotional and behavioural problems among high-risk adolescents. *Clinical Child Psychology and Psychiatry*. doi:10.1177/1359104518822690

[3] Participants overlapped with the sample of the first study.

The attentional response is measured by the reaction time needed to respond to an asterisk (i.e., the dot-probe), which replaces either an emotional or a neutral picture (presented for 250 ms) (Figure 2-1). The response time is recorded in milliseconds from which a set of facilitation indices are calculated (MacLeod & Mathews, 1988): Distress facilitation = 1/2 x [(Neutral Only/Probe Up - Distress Up/Probe Up) + (Neutral Only/Probe Down - Distress Down/Probe Down)].

Because the emotional quality of the pictures is thought to direct the focus of attention and enhance processing (Öhman, Flykt, & Esteves, 2001), it is assumed that participants will respond faster to probes replacing emotional pictures, as their attention is already directed to the location where the probe appears. Higher facilitation indices mean greater attention to emotional pictures (Kimonis et al., 2006). The dot-probe task used in the present study was made available to us by Dr. Eva Kimonis.

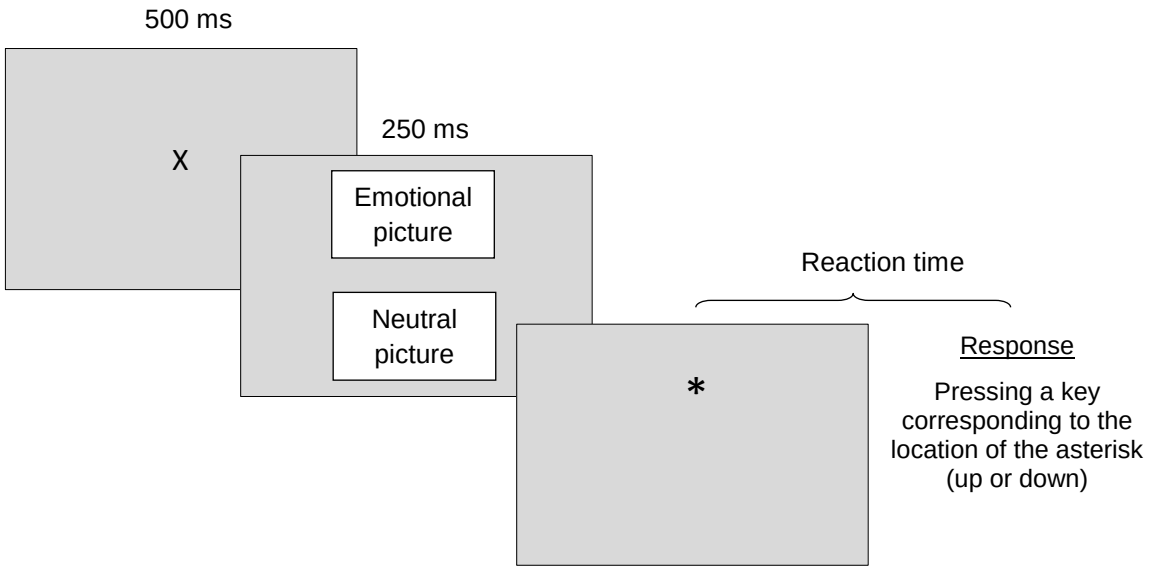

Figure 2-1. Illustration of the dot-probe task.

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Eötvös Loránd University.

2.2. Main results

According to the results, there were significant correlations between ICU total scores and three of the five SDQ subscales. CU traits were significantly and positively correlated with conduct problems (r = 0.63, p < 0.01), hyperactivity-inattention (r = 0.56, p < 0.01) and negatively associated with prosocial behaviour (r = -0.61, p < 0.01). Facilitation to distress pictures was significantly and negatively associated with CU traits (r = -0.20, p < 0.05), conduct problems (r = -0.21, p < 0.05), hyperactivity-inattention (r = -0.21, p < 0.05) and positively associated with prosocial behaviour (r = 0.25, p < 0.05). Neither CU traits nor facilitation to distress were significantly correlated with emotional and peer problems. Facilitation to positive pictures was uncorrelated with the main study variables.

At the next step, a series of hierarchical regression analyses were conducted to test the potential moderating effects of emotional symptoms, conduct problems, and hyperactivity-inattention on the association between CU traits and the attention to emotional cues. According to the results, there was a significant interaction for distress facilitation indices, but not for

positive content. The interaction between CU traits and conduct problems was significant (β = -0.23, p = 0.02), suggesting that the relationship between CU traits and facilitation to distress depended upon the level of conduct problems. The effect remained significant even after controlling for emotional and hyperactivity-inattention symptoms (β = -0.24, p = 0.02).

Figure 2-2 presents a graphical representation of the interaction between CU traits and conduct problems. Post-hoc simple slope analysis indicated a significant negative association between CU traits and distress facilitation for high levels of conduct problems (t(99) = -2.01, p < 0.05). Results state that the distress facilitation level decreased significantly in the high conduct problems group under low, medium and high CU traits conditions. The slopes for low and medium levels of conduct problems did not differ significantly from zero.

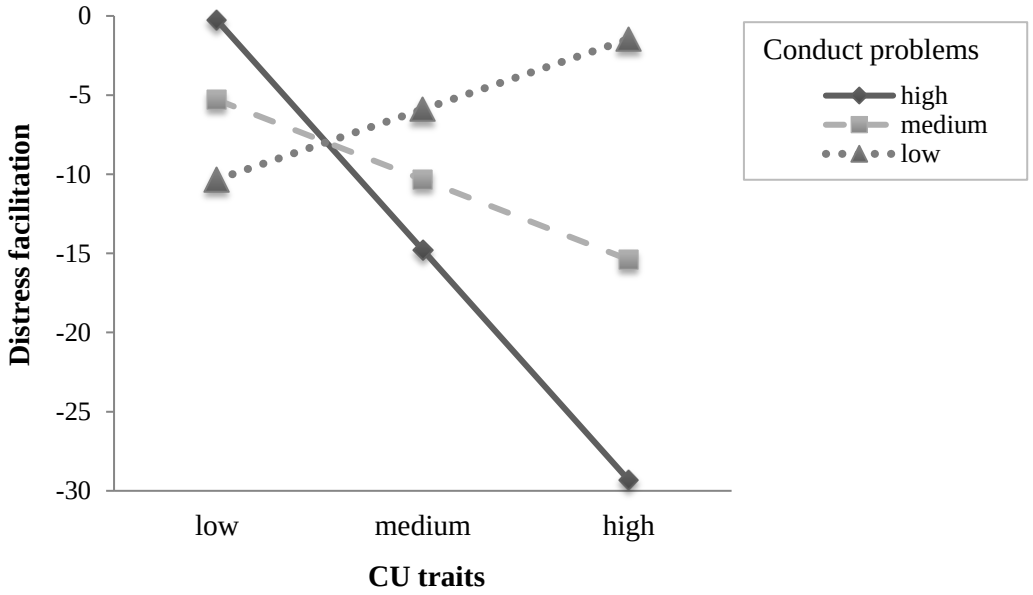

Figure 2-2. Interaction between callous-unemotional (CU) traits and conduct problems on facilitation to distress.

2.3. Discussion

The main goal of the second study was to test the link between CU traits and attentional bias towards emotional stimuli in a high-risk sample of adolescent boys. The current results provided support for the hypothesis that CU traits are related to reduced attention to emotionally distressing cues. Furthermore, conduct problems significantly moderated the link between CU traits and emotional deficit. That is, when the level of conduct problems was high, the responsiveness to distress cues decreased as CU traits increased.

The current findings are consistent with a significant body of research that suggests that the combination of conduct problems and CU traits designates an important subgroup of youth showing deficits in the processing of negative emotional stimuli (Jones et al., 2009; Kimonis et al., 2006; Kimonis, Frick, Muñoz, et al., 2008). The findings reported here are also in line with the notion that antisocial youth without CU traits are characterized with heightened reactivity to distress stimuli (Kimonis et al., 2006; Kimonis, Frick, Muñoz, et al., 2008; Kimonis et al., 2018). These results emphasise the importance of being able to determine subgroups of youth classed as "antisocial" that may have different developmental pathways to severe conduct problems (Frick & Morris, 2004).

There was no significant association between CU traits and emotional symptoms which might be explained by the two variants (primary and secondary types) of CU traits not identified in the present study. Hyperactivity-inattention was significantly and negative associated with facilitation to distress pictures and positively with CU traits, but it did not have a moderating effect on the link between CU traits and attentional bias towards emotional stimuli. Although our study provided some support for Lynam's model (1996), the absence of a significant interaction between CU traits and hyperactivity-inattention symptoms in predicting distress facilitation is consistent with other research that suggests that the presence of conduct problems is more important when considering deficits associated with psychopathic features among adolescents (Michonski & Sharp, 2010; Smith & Hung, 2012).

The current results highlight the importance of investigating the impact of CU traits and conduct problems on emotional processing both as distinct factors and in combination. Our study also supports the need to continue testing the potential moderators to the association between CU traits and emotional deficits. Finally, based on our findings, CU traits help to define a subgroup of antisocial youth showing deficits in attention to emotional stimuli that should be taken into consideration into improving the effectiveness of interventions or treatment programmes. Treatments aiming to increase sensitivity to distress based social cues might be helpful to reduce the level of antisocial behaviour among youth with CU (Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012; van Baardewijk, Stegge, Bushman, & Vermeiren, 2009).

3. study: Callous-unemotional traits and neural responses to emotional faces in a community sample of young adults[4]

In our third study we investigated the neural correlates of emotional processing in a noncriminal sample. In the current study, fMRI blood-oxygen-level-dependent (BOLD) responses to fearful, happy and sad expressions compared to neutral faces were assessed. On the basis of prior research and theory (Blair, 2005; Kiehl, 2006), it was hypothesized that CU traits would be associated with reduced amygdala and ACC activity to distress-related cues (i.e., fearful and sad expressions). To the best of our knowledge, this was the first fMRI study assessing whether CU traits are accompanied with reduced activity in these two particular structures in a community sample of young adults (males and females).

3.1. Methods

3.1.1. Participants

This study reports data from 41 healthy adult volunteers (25 females, mean age: 25.44 years, *SD* = 4.03). All participants were right-handed and had no history of medical, neurological or psychiatric disease.

3.1.2. Measures

Participants completed basic demographic questions and CU traits were measured by the ICU (which has been validated in adult samples as well). In the present study, the total ICU score demonstrated adequate internal consistency (Cronbach $\alpha = 0.76$).

Emotional processing was measured by an implicit facial expression recognition task. Stimuli comprised six adult faces (three male and three female individuals) making three emotional (fearful, happy, sad) and neutral expressions (Ekman & Friesen, 1976). Participants viewed blocks of face stimuli separated by three rest blocks where a fixation cross appeared at the centre of the screen (Figure 3-1). Stimulus presentations were delivered by E-Prime 2.0 (Psychology Software Tools, Inc., Pittsburgh, USA). To ensure that participants were attending to the stimuli, they were required to categorize the sex of each face stimulus using two response buttons. Accuracy and reaction times were recorded throughout the task.

Figure 3-1. Experimental paradigm (block design).
N = neutral, H = happy, S = sad, F = fear; R = rest blocks.

[4] The present chapter is based on the following publication: Szabó, E., Kocsel, N., Édes, A. E., Pap, D., Galambos, A., Zsombók, T., Szabó, Á. Gy., Kozák, L. R., Bagdy, Gy., Juhász, G., & Kökönyei, Gy. (2017). Callous-unemotional traits and neural responses to emotional faces in a community sample of young adults. *Personality and Individual Differences, 111*, 312–317.

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Scientific and Research Ethics Committee of the Medical Research Council.

3.2. Main results

There were no significant correlations between reaction time data and ICU scores (neutral: r = 0.16, p = 0.31; fear: r = 0.19, p = 0.23; happy: r = 0.14, p = 0.37; sad: r = 0.24, p = 0.14), but there was a significant difference regarding CU traits between male (M = 21.44, SD = 6.16) and female participants (M = 16.08, SD = 5.15; $t(39)$ = 3.01, p = 0.005, Cohen's d = 0.92).

Main effects of the faces task used in the present fMRI study can be seen in Table 3-1 and Figure 3-2.

Table 3-1. *Main effects of the task in all participants*

Cluster size (number of voxels)	Region	Side	FWE	MNI coordinates			peak *T*
				x	y	z	
Fear							
44	Amygdala	Right	< 0.001	24	-4	-16	5.87
16	Amygdala	Left	0.002	-21	-4	-16	4.38
287	Fusiform Gyrus	Left	< 0.001	-21	-85	-13	7.48
236	Fusiform Gyrus	Right	< 0.001	30	-76	-16	6.95
Happy							
245	Fusiform Gyrus	Left	< 0.001	-36	-76	-13	5.39
Sad							
215	Lingual Gyrus	Left	< 0.001	-3	-79	-10	5.73

Note. Voxels are significant at p_{FWE} = 0.05, with small volume and peak-level correction for multiple comparison. Coordinates are in Montreal Neurological Institute (MNI) space.

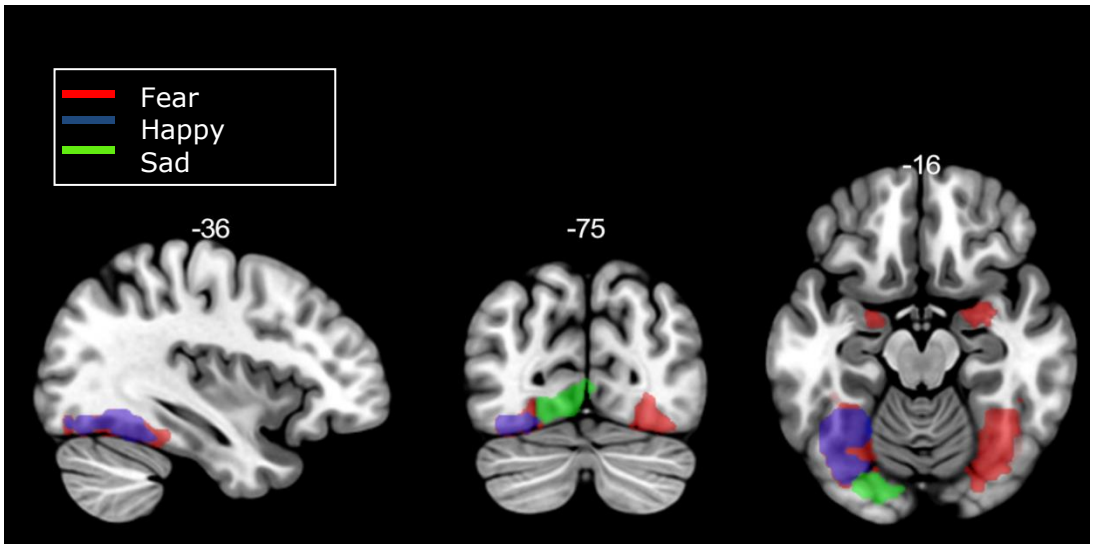

Figure 3-2. Increased neural activation to emotinal faces compared to neutral facial expressions. Based on a large meta-analysis (Fusar-Poli et al., 2009), region-of-interest (ROI) analyses were performed. Fearful-neutral contrast evoked increased activation in the bilateral amygdala and bilateral fusiform gyrus (*red*). Happy-neutral contrast was related to significant activation in the left fusiform gyrus (*blue*). Sad-neutral contrast evoked activation in the left lingual gyrus (*green*). The images are thresholded at p_{FWE} = 0.05, $k \geq 5$, with small volume and peak-level correction for multiple comparison. MNI coordinates: x = -36, y = -75, z = -16

After controlling for sex, ROI analyses revealed that during exposure to fearful face expressions (relative to neutral faces), BOLD responses were negatively associated with CU traits in the right anterior cingulate gyrus (r = - 0.47, p = 0.002), but not in the amygdala (see Figure 3-3).

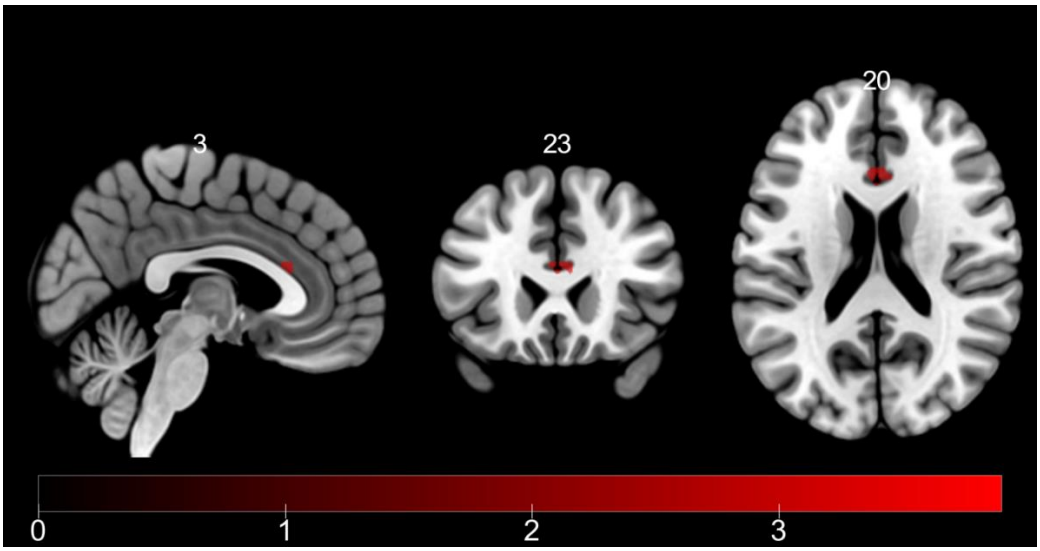

Figure 3-2. Reduced activation to fearful faces in the anterior cingulate gyrus.
MNI coordinates: x = 3, y = 23, z = 20. The images are thresholded at $p_{FWE} = 0.05$, $k \geq 5$, with small volume and peak-level correction for multiple comparison. Scale represents the T score.

3.3. Discussion

Our third study investigated the link between CU traits and neural responses to facial expressions in a community sample of young adults. Facial processing was measured by a widely used emotional faces paradigm and the main neural effects of the task were in line with previous findings (Fusar-Poli et al., 2009). Contrary to our expectations, CU traits were not associated with decreased amygdala response to distress-related cues (i.e., fearful and sad expressions). However, in line with our hypothesis, CU traits were related to lower ACC activation in response to fearful faces.

To our knowledge, this is the first imaging study to demonstrate that CU traits are associated with reduced right anterior cingulate responsiveness during exposure to fearful expressions in a noncriminal sample. More specifically, reduced activity of the anterior cingulate gyrus (ACCg) was found to be related to CU traits. This finding is in accordance with recent anatomical and functional evidence suggesting that the ACCg plays a crucial role in processing information about others (Apps, Rushworth, & Chang, 2016; Lockwood, 2016). Our finding is also in line with Lockwood et al. (2013), who found that activity in ACCg was negatively associated with callous traits among children with conduct problems during viewing pictures of others in pain.

It can be concluded that, although previous work has demonstrated impaired amygdala function in community population, this deficit may not be as pronounced. There is evidence to suggest that amygdala functioning is deficient in noncriminal samples to a lesser extent than seen in criminal samples (Raine & Glenn, 2014). Our findings give further support that the core affective features of psychopathy are associated with a unique neural signature in the normal population as well. Our results also highlight the importance of considering other regions of the limbic system outside the amygdala, particularly the ACC, when investigating the association between callous characteristics and fear response.

CONCLUSION

Our studies focused on externalizing symptoms and deficits in emotional processing, both of which play central roles in theories and research on CU traits. In our studies, valid and widely used measures were selected, such as the ICU (Frick & Hare, 2001), the emotional pictures dot-probe task (Kimonis et al., 2007) and an implicit facial expression recognition task (Ekman & Friesen, 1976).

In summary, our results supported that the Hungarian ICU (Pataky et al., 2011) is a reliable and valid instrument to assess CU traits and can be used among high-risk adolescents. Furthermore, we found that boys with high levels of CU traits and conduct problems show reduced attentional orienting to distressing cues. And finally, our findings give further support that CU traits are associated with reduced neural response to negative emotional stimuli in noncriminal population as well.

The strengths of our studies lie in the use of cognitive paradigms and fMRI to measure emotional processing. In this way, we were able to support that CU traits are related to reduced emotional response on the automatic or implicit level. However, additional studies are needed among high-risk girls (e.g., juvenile offenders), and future studies should also distinguish between the two types of CU traits (primary and secondary variants). It would be also interesting to determine how other important dimensions of psychopathic traits (i.e., grandiose-manipulative and daring-impulsive traits; Salekin, 2017) are related to emotional processing.

Finally, our findings imply that youth with conduct problems and CU traits might benefit from different treatments than antisocial youth without these traits. Previous research has already suggested that aggression can be attenuated in youth with psychopathic traits by increasing the salience of distress cues in others (van Baardewijk et al., 2009). In addition, improved affective empathy and conduct problems have also been reported after expression recognition training in children with high levels of CU traits (Dadds et al., 2012).

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[5] All co-authors have granted permission for these publications to be included in the dissertation.

Other publications

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