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Psychometric properties of Attentional Control Scale: The preliminary study on a Polish sample

The presented study was focused primarily on a psychometric analysis of the Attentional Control Scale (ACS), but they also enhanced the understanding of the role of effortful attentional skills in determining the individual well-being, general adaptation or emotional disorders. The analyses included basic item and scale descriptions as well as convergent and discriminant validity. 218 Polish undergraduate students completed the battery of the self-report techniques and two paper –pencil attentional tests. Data revealed a unidimensional of a 20-item ACS. It can be used validly to assess long-term individual differences in attentional skills related to the voluntary executive functions. The analysis of content, internal and construct validity as well as reliability provided evidence of the scale's significant convergent and discriminant validity when correlated with attentional tests and other personality techniques. We found strong, systematic relations between the attentional control and selected measures of temperament, arousal, emotionality, and motivation. The results allow assuming that good attentional control, may protect individuals from the emotional disorders by regulating perceptual, conceptual, and response processing.

Keywords: *Attentional Control Scale, psychometric properties, effortful attentional control, individual differences, well-being, emotional disorders*

Introduction

Recent research indicates that the attentional system is not unitary (e.g., Miller & Cohen, 2001; Corbetta & Shulman, 2002). Posner and his colleagues have described an *anterior attentional system* that functions in relation to more reactive *posterior attentional and vigilance systems,* and regulates automatic pathways throughout the cortex (Posner & Petersen, 1990; Posner & Rothbart, 1998). The distinction between anterior and posterior attentional systems seems to be relevant to the Attentional Control Scale (ACS) characterized in this paper.

The anterior system (associated with left hemisphere, anterior cingulate cortex, limbic and frontal motivational systems) is viewed as an executive system that carries out more voluntary attentional functions e.g., inhibition of dominant response tendencies and conceptual associations. Additionally, this system is responsible for more voluntary and flexible attentional control (*AC*), while the posterior system (connected with right hemisphere and parietal lobe) is often reflexive and responds in a fairly automatic way when attention orients to stimuli or environmental events (Derryberry, 2002).

Much of the research examining individual differences in *AC* mechanisms have focused on tasks that primarily engage the posterior attentional system (Fajkowska & Eysenck, 2008). However, a range of studies looking at the determinants of individual general adaptation suggests that a crucial contribution to it might be viewed in a balance between posterior and anterior systems of *AC* (Eysenck et al., 2007). Thus, it is vitally important to study effects of these two systems on individuals' cognitive, emotional, motivational processes and behaviours (Fox, 2008). The functions of the posterior attentional system has been so far extensively explored whereas the functions of the anterior attentional system are relatively unknown. One possible way to make a progress in this aspect is to extend research on psychometric properties of the ACS.

Derryberry and Reed (2001) have developed a self-report instrument to assess individual differences in attentional

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skills related to voluntary executive functions. They proposed a 20-item ACS, which measures one's ability to focus perceptual attention, switch attention between tasks, and flexibly control thought (Derryberry, 2002).

The scale is based on the view that the executive mechanisms, usually associated with attention and the frontal lobe, regulate the more reactive networks of the posterior cortex and very good approximate the intentional nature of voluntary self-control (Derryberry & Tucker, 2006) and that individuals put an active *effortful control* to cope with their reactivity (Rothbart et al., 1994; Derryberry & Reed, 2008). Underlined by anterior system effortful control, as part of executive attention, is viewed as involved in the awareness of one's planned behaviours and subjective feelings of voluntary control of thoughts and feelings, and is believed to come into play when resolving conflicts, correcting errors, and planning new actions (Eisenberg et al., 2004).

The initial stages of scale construction began with a study by Derryberry and Rothbart (1988). They proposed scales to measure the voluntary *attentional focusing* and *attentional shifting* related to anterior system functioning. These scales were positively correlated with one another and negatively correlated with scales measuring fear, frustration, and sadness. In more recent studies, Derryberry and Reed (2002) have combined the attentional focusing and shifting scales to form a measure of effortful *AC*. The instruction inform that the questions deal with how subject performs in general, not at the particular point of time. Validation of the ACS to the anterior function of regulating the posterior orienting was documented several times (Derryberry & Reed, 2001; 2002; 2003). However, the psychometric status of this scale has not been adequately established. Thus, in this paper we report the preliminary findings regarding validity and reliability of the scale from a Polish sample.

Method

Participants

218 undergraduate students enrolled in various faculties at university and polytechnic (142 females, 76 males; mean age 22.14 years, *SD*= 2.93) completed a battery of the self-report techniques and two paper–pencil attentional tests during three distinct testing sessions.

Procedure

Three experts in American English and cognitive and individual differences psychology translated the ACS from English to Polish. Three experts in Polish and in psychology then checked the convergence of three Polish versions with reference to wording and content. On this basis, the draft of the Polish version was prepared, which was then backtranslated into the original language by other three experts. Two English translators verified the convergence between the second English version and the original scale. Experts in Polish and in psychology improved the language structure and content of the Polish version and prepared the final Polish version of ACS. Fourteen bilinguals completed both versions of the test in a two-week gap. Satisfactory correlations between the two versions of test (*Pearson's r,* .83, $p < .01$) and between pairs of test items (*Spearman's rho*, .71, $p <$. 01 - .94, $p <$. 01 for fifteen items; .26, $p <$. 01 - .61, $p <$. 01 for five items) were obtained and utilized to improve the translations of items with the lowest parameters.

Results

Means and Standard Deviations

Table 1 illustrates the basic descriptive statistics for ACS items. No large or consistent gender differences on test positions were found, so data are collapsed across gender. Nevertheless, it is recommend testing for gender differences in any new sample.

Subjects can get four points for each item, so the lowest possible score is 20 and the highest is 80. The mean score for the 20-item scale is 54.49 and *SD*= 15.02 on a Polish sample and these results tend to be very similar to the results obtained in different American samples (*M*=51-53).

Validity of the ACS

Content and internal validity

There are claims that the domain of ACS seems not to be particularly clear-cut and rather covers some aspects of temperamental than cognitive characteristics of behaviour (Strelau, 2002). To meet this criticism, the four competent judges were instructed to indicate 20 from 45 items which could potentially exam attentional functions – control, shifting, concentration - and then to rank them from the most to the least suitable (items could receive the same position on the list of concerns). The set of 45 items was a combination of 20 items from the ACS and 25 items from the shortened version of the Formal Characteristics of Behavior - Temperament Inventory measuring endurance, perseveration, sensorysensitivity, emotional reactivity, activity, and briskness (Zawadzki & Strelau,1997). Generally, all the judges were very accurate in selecting 20 original attentional items from the list of 45. They missed only two original items (9; 20) and replaced them with those measuring temperamental endurance.

There was an overall trend of agreement among the judges that the ACS is a relevant test for its purpose (Kendall's $W = .993$, $\chi^2 = 71.36$, $df = 19$, $p < .001$; 83% of total variance of ratings). However, there were five problematic items (9; 10; 11; 13; 20) with the very high *Rj* values, which indicates a need for another index of test validity.

Table 1
Item descriptives for the Polish adaptation of ACS (N=218).

Variables			Factor loadings One-factor solution	Factor loadings Three-factor solution			Test- retest coefficients (r_{tt})
	M	SD	Component	Components			
				1	2	3	
1. It's very hard for me to concentrate on a difficult task when there are noises around	2.60	.76	.64	.57			.66**
2. When I need to concentrate and solve a problem, I have trouble focusing my attention	3.01	.66	.67	.49			.55**
3. When I am working hard on something, I still get distracted by events around me.	2.93	.69	.70	.50			.60**
4. My concentration is good even if there is music in the room around me.	2.64	.90	.58	.		-.58	.73**
5. When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me.	2.20	.73	.43			-.40	.52**
6. When I am reading or studying, I am easily distracted if there are people talking in the same room.	2.44	.86	.66	.64			.68**
7. When trying to focus my attention on something, I have difficulty blocking out distracting thoughts.	2.73	.72	.63	.66			.60**
8. I have a hard time concentrating when I'm excited about something.	2.31	.79	.49	.70			.60**
9. When concentrating I ignore feelings of hunger or thirst.	2.13	.90	.27	.49			.59**
10. I can quickly switch from one task to another.	2.87	.71	.68		.60		.60**
11. It takes me a while to get really involved in a new task.	2.88	.71	.58		.69		.50**
12. It is difficult for me to coordinate my attention between the listening and writing required when taking notes during lectures.	3.32	.76	.55		.47		.66**
13. I can become interested in a new topic very quickly when I need to.	3.03	.71	.64		.70		.54**
14. It is easy for me to read or write while I'm also talking on the phone	2.97	.82	.53			-.69	.59**
15. I have trouble carrying on two conversations at once.	2.85	.84	.60			-.58	.58**
16. I have a hard time coming up with new ideas quickly.	3.13	.63	.60		.72		.50**
17. After being interrupted or distracted, I can easily shift my attention back to what I was doing before.	2.67	.71	.58	.33			.45**
18. When a distracting thought comes to mind, it is easy for me to shift my attention away from it.	2.21	.71	.60	.67			.66**
19. It is easy for me to alternate between two different tasks	2.71	.78	.72		.	-.58	.63**
20 . It is hard for me to break from one way of thinking about something and look at it from another point of view.	2.98	.71	.51		.55		.46**

**p< .001

The ability of items to produce a spread of scores is demonstrated by the coefficients of corrected item-total correlations (r_{it}) (Gregory, 2004). We found high item-discrimination coefficients ranging from .29 to .63. Consequently, a good discriminatory power of the items reflects a satisfactory homogeneity of the test (- .88; Cronbach's alpha).

Such results could be regarded as evidence for the appropriate qualities of content and internal validity of the ACS.

Construct validity

Signal detection indices and AC

Performance on tasks that impose substantial demands on the voluntary attentional control system, for instance those formed by the prolonged visual search design (Mackworth, 1948; 1957), should correlate with ACS scores. Thus, 211 participants across two studies completed the ACS and then 100 of them took the paper-and-pencil *d2* Test of Attention (Brickenkamp & Zillmer, 2003; Dajek, 2003) and 111 - the Emotional Faces Attention Test (modification of the Attention Test by Moron; Fajkowska, 2009). In the previous test individuals were expected to scan 14 lines with 47

Table 2
Varimax-rotated factor loadings* of the individual properties measured by EPQ-R, PTS and ACS (N = 218).

	Component	
	1	2
Strength of Excitation (SE)	.88	
Strength of Inhibition (SI)		.71
Mobility of Nervous Processes (MO)	.84	
Extraversion (E)	.72	
Neuroticism (N)	-.68	
Psychoticism (P)		-.69
Lie Scale/ Social Desirability (SD)		.75
Attentional Control (AC)	.87	

Extraction Method: Principal Component Analysis; KMO=. 783; Loadings below .40 are omitted

**Oblimin roation: very low negative correlation between two factors*

characters in each line and *cross out all occurrences of the letter 'd' with two dashes* while ignoring letters *'d'* or *'p'* marked with one, three or four small dashes in 4 minutes (searching condition). After the distraction trial they were asked to scan the lines and *not cross out all occurrences of the letter 'd' with two dashes* while cross out all other characters in 4 minutes (inhibition condition). The other test is composed of 386 Ekman's pictures of emotional facial expressions, arranged in 24 x 16 blocks on a standard sheet of paper with three target expressions (happiness, anger, sadness) presented randomly. The task was to cross out a signal face as quickly as possible, in a matrix of faces in 2 minutes.

In both studies, the correlations between *AC*, hits, false alarms, omissions and Beta index were analyzed and it was shown that the effortful *AC i*s not related to the detection of non-emotional and emotional signals. The only significant positive correlation (.20, $p<.01$) was found between *AC* and the processing of happy faces (hits). This finding may be a consequence of the strategic nature of positive information, which consists in a less automatic and more voluntary properties of attention to happiness than to threat (Derryberry & Reed, 2002).

AC, arousal and temperament

Our studies confirmed that *AC* positively relates to Extraversion (.46, $p<.001$) and negatively to Neuroticism (-.55, $p<.001$) (EPQ-R) (see Derryberry & Reed, 2001; 2003). Consequently, a positive correlation was also found between AC and Pavlovian temperamental traits reflecting strong nervous system: Strength of Excitation (.79,$p<.001$), Strength of Inhibition (.39, $p<.001$) and Mobility of Nervous Processes (.67, $p<.001$) (PTS; Strelau et al., 1999).

The presented above relations between *AC* and Eysenckian and Pavlovian traits might also be explained in terms of arousal and effort (Pavlov, 1938/1952; Eysenck, 1987; Strelau, 2008). For example, extraversion or neuroticism is associated with attentional biases to process different classes of information (Muris et al., 2004; Fox, 2008). Hence, a stimulation reducing mechanism in extraverts may modulate directly the activity of the anterior attentional system, while stimulation augmenting mechanism in neurotics may recruit the posterior attentional system and induce arousal (Strelau, 1998; Eysenck & Eysenck, 1994). Consequently, attention can be allocated in a more deliberate way or in a fairly automatic way to some environmental events, respectively. Obviously, it may be the one possible explanation of the relations between temperamental properties and effortful *AC* and the future research should aim to clarify their optimal interpretation.

The arousal is not a unitary concept, but it comprises separate constructs that are regulated by different neural substrates, depending on environmental or task demands (McGuinness & Pribram, 1980; Tucker & Williamson, 1984; Robbins, 1997; De Brabander et al., 2002; Fajkowska & Krejtz, 2007). For example, Thayer (1989; 2000) discriminates two independent dimensions of phasic activation (arousal): energy vs. tension (Yik et al., 1999; Schimmack & Reisenzein, 2002).

Thus, providing that the effort invested in acting or performance comes from the momentary arousal initiated by the situational factors, it might be expected that changes in the phasic activation affect the effortful *AC*. Utilizing the Activation-Deactivation Adjective Check List by Thayer in this study it was demonstrated that *AC* negatively relates to „energetic arousal" (-.36, $p<.001$ for energy and for -.27, $p<.001$ calmness) and positively to „tension arousal" (.28, $p<.001$ for tension and .29, $p<.001$ for tiredness). Thus, increased „energetic arousal" reflects decreased *AC* and vice versa. It is conceivable that at an early stage of performance the „energetic arousal" intensifies the volitional *AC*, which in turn contributes to the decrease of „energetic arousal" at the later stage of performance. The pattern of association between „tension arousal" and volitional *AC* suggests more attentional focusing when the level of 'tension arousal" rises.

The logic behind this explanation assumes the potential modulating effect of the interaction between temperamental properties related to arousal and effort on the activity of the anterior attentional system. Hypothetically, in neurotic extroverts (low capacities of processing stimulation; ineffective regulation of stimulation; Zawadzki & Strelau, 1997) the increase of tension arousal, that is usually higher in them, facilitates the volitional *AC* and makes them more careful and concentrated. It would be analogous to a decrease of a usually lower energetic arousal in them. That in turn enhances the increase in their *AC* (Nęcka, 2000).

The common mechanisms underlying *AC* and those properties is an open question. It is conceivable that the same brain areas play an important role in both volitional *AC* and personality traits related to arousal, because the

ability to modulate or re-direct attention is linked with the capacity to maintain the optimal level of arousal (e.g., Canli et al., 2002; 2004). Following this hypothesis, we have been conducting the studies on temperament, *AC* and EEG signals during detection of emotional facial expressions. So far, the answer to the hypothesis stated above may be approximated by a different approach. Namely, we have factored the Pavlovian and Eysenckian personality traits and *AC* using the principal components factor analysis with varimax and oblimin rotations (Kline, 1994). To determine the final number of factors, a range of solutions starting at two factors' solution was examined, until we reached the solution that contained an uninterruptible factor (i.e. one with less than three marker terms). Hence, in Table 2, the best, two-factor solution (total variance explained 64.4%) is shown.

The first factor can easily be identified as composed of effort- and arousal- related individual properties. It reveals itself in the adequate responses to strong or prolonged stimulation (SE), high endurance and capacities of processing stimulation (E), flexible, non-anxious attentional control (AC) and flexible processing stimulation (MO), and seems to constitute more 'biologically rooted capacities of control'. The second factor is defined by strong processes of conditional inhibition (SI), the cautious way of acting (P), and high social desirability (SD), what composes more 'environmentally rooted abilities of control'. Until further evidence is available, we can only assume a strong association between effortful *AC* and arousal-related personality traits and the common mechanisms underlying these constructs.

AC, motivation and emotions

On activation, the behavioural inhibition system (BIS) produces the emotion of anxiety, comprising, risk-assessment, rumination, checking for potential punishment, and its major motivational function is to inhibit prepotent conflicting behaviours (Corr, 2009). The behavioural approach system (BAS) generates the emotions of appetitive hopefulness and 'anticipatory pleasure' and is associated with optimism, reward-orientation and impulsiveness (Gray, 1991; Corr et al., 1997). We have found that the effortful *AC* is related negatively to BIS (-.53, $p < .001$) and positively to BAS (Drive: .22, $p < .001$; Fun Seeking: .22, $p < .001$ scales) [BIS/BAS Scales; Carver & White, 1994; Müller & Wytykowska, 2005]. These findings might indicate that volitional *AC* is not involved in BIS (linked with negative affectivity), which operates in more automatic way. Probably BAS (associated with positive affectivity) involves the access to the executive systems in order to generate voluntary intentions.

Consequently, this study revealed a positive relationship between *AC* and Positive Affect (.38, $p<.001$) and its content (joviality, self-assurance and attentiveness - from .30 to .50) and a negative relationship between *AC* and Negative Affect (-.54, $p < .001$) and its content (fear, hostility, guilt and sadness - from -.34 to -.51) (PANAS-X: Watson & Clark, 1994; Fajkowska & Marszał-Wiśniewska, 2009).

In accordance with these results, the *AC* is positively correlated with the adaptive strategies of cognitive emotional regulation (from .14 to. 41, $p < .001$) and negatively with maladaptive strategies (from -.34 to -.46, $p < .001$) [CERQ: Garnefsky et al., 2001; 2002; Marszał-Wiśniewska & Fajkowska, 2009]. Among the four analysed adaptive strategies, *Refocus on Planning (*.32) and *Positive Reappraisal (*.41) have the strongest moderate positive associations with effortful AC. *Catastrophizing* (-.46) *Rumination* (-.38) *Self-blame* (-.35) *Other-blame* (-.34) non-adaptive strategies are negatively and moderately related to *AC*.

Speculatively, the efficiency of general self-regulatory system might involve i.e., good volitional AC, positive affectivity, and adaptive cognitive emotional regulation. However, this efficiency is likely to be constrained by the individual's attentional capacities owing to the fact that attention helps to stabilize information in memory, particular skills, and affective tendencies and strategies which should progressively shape the self-concept (Derryberry, 2002). People with better *AC* may be able to exploit the more adaptive strategies, whereas people with more limited *AC* may be forced to rely on maladaptive strategies.

Theory-consistent group differences

The outcomes of the research suggest that the presence of symptoms of depression or anxiety could point at the negative affectivity (Watson, 2000; 2005) and the use of – perhaps long established – non-adaptive cognitive coping strategies (Garnefsky et al., 2002). The results from this study allow assuming that good *AC* may protect the individuals from the emotional disorders by regulating perceptual, conceptual, and response processing. Logically, poor *AC* should be expected in anxious or depressed individuals (Derryberry, 2002; Derryberry & Reed, 2002). Along with this line of thinking we assessed the differences in effortful *AC* between trait-anxious and non-anxious individuals (STAI: Spielberger, 1988; Wrześniewski & Sosnowski, 1996), and between depressed and non-depressed individuals (BDI: Parnowski & Jernajczyk, 1977; Beck et al., 1987). Results showed that trait-anxious subjects (M= 50.01) scored significantly lower on the effortful *AC* than non-anxious individuals *(*M=58.82), t=9.09, df=212, $p<.001$. Similarly, the depressed mood individuals (M=50.83) were significantly lower on the *AC* than non-depressed participants *(* M=56.20), t=4.49, df=216, $p< .001$.

Factorial validity

Factor analyses usually resolved three to four factors, however it was found that the scale measures a general capacity for *AC,* with correlated subfactors related to the perceptual focusing, shifting, and cognitive flexibility.

The item scores were subjected to principal-components analyses specifying one-solution and then three-, four- and five-factor solutions using varimax and oblimin rotations. By utilising all these methods one-factor solution (*KMO*=. 88; total variance explained 35.4%) and three-factor solution (*KMO*=. 87; total variance explained 47.8 %) emerged as the most suitable for psychological interpretation (Table 1).

The data clearly demonstrated that all the items are strong markers of the extracted single factor. In accord with the results from the content validity analysis, the only exception is item 9 with the lowest loading.

The three factors could be identified as 'attentionalFocusing' (Component 1), 'attentional shifting'(Component 2) and 'divided attention' (Component 3). These factors are relatively independent with correlations: .28 for 'attentional focusing' and 'attentional shifting';-.27 for 'attentional focusing' and 'divided attention'; -.26 'attentional shifting' and 'divided attention' (cf. Derryberry & Rothbart, 1988). However, these factors do not contain enough markers in them to support reasonable internal consistency, which inclines to give the green light to the single factor solution as the most representative.

Reliability estimation

According to the results the test-retest (r_{tt}) reliabilities are moderate after one month, for ACS items varying from .45 to .73 (Table 1), and for the total score is .61. Internal consistency reliabilities are high – the alpha Cronbach is .88 (cf. Derryberry & Reed, 2001), the Spearman-Brown coefficient is .82 and the Guttman split-half coefficient is .82. Concluding, the internal consistency of the test is high while its stability is not satisfactory.

Summary

The extensive data presented here indicate that trait scores on the ACS (a) show significant convergent and discriminant validity when correlated with attentional tests and other personality techniques, (b) are good discriminatory tools for affective disorders and (c) are strongly and systematically related to measures of temperament, arousal, emotionality and motivation. These data clearly demonstrated that, with the possible exception of some items, the scale can be used validly to assess long-term individual differences in volitional attentional control.

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