research note

The ANT in a Russian Sample: Testing the Independence of Attention Networks

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Abstract. The Attention Network Test (ANT) is a measure that allows assessment of the three different attention networks postulated by Posner and Peterson (1990): alerting, orienting, and executive control. The ANT became a popular tool for assessing the functioning of attention networks due to its simplicity, relative brevity, and accessibility for researchers. The data obtained with the ANT in a Russian sample are reported in this study. The analysis was focused on the question of independence of the attention networks. It has been shown that the orienting and executive control networks are not independent from one another since these networks scores yielded a significant correlation. Furthermore, an interaction was found between cue types and flanker types.

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Contemporary psychological and neuropsychological research on attention often involves use of the Attention Network Test (ANT). This measure is based on the influential model suggested by Posner and Petersen (1990). They subdivided the human attentional system into three independent networks, namely: alerting, orienting, and executive attention, also called executive control. These three attention networks are supposed to differ in their functions and underlying neuroanatomical structures. The alerting network is responsible for the maintenance of a vigilant and alert state. The orienting network allows for a shift of attention to sensory events appearing in the perceptual field, and is responsible for the selection of information from sensory input. Meanwhile, the executive control network allows for resolving conflicts among responses.

The ANT, a computerized test for measuring these three attention networks, was developed by Fan and his colleagues (Fan, McCandliss, Sommer, Raz, & Posner, 2002). The ANT became a popular tool thanks to its simplicity, relative brevity, and accessibility for researchers. The procedure integrates a classical flanker task (Eriksen & Eriksen, 1974) and Posner's cued reaction time task (Posner, 1980). The structure of a trial is presented in Fig. 1. A trial starts with the presentation of a fixation cross (400–1600 ms) followed by one of four types of cues (100 ms). In the center cue condition, an asterisk appears on the fixation cross. The double cue condition is the simultaneous appearance of two asterisks, one above and one below the fixation cross. In the spatial cue condition, an asterisk appears either above or below the fixation cross and predicts the future target location. Finally, in the no cue condition, no asterisk appears. Following the cuing, 400 ms later, one of three types of targets is presented. A target consists of an arrow flanked either by four arrows pointing in the same direction as the central arrow (congruent condition), or by four arrows pointing in the opposite direction (incongruent condition), or by four straight lines (neutral condition). The target appears above or below the fixation cross. In general, there are twelve types of trials (four types of cues × three types of targets). A participant should respond to the direction of the central arrow by pressing the corresponding predefined keys.

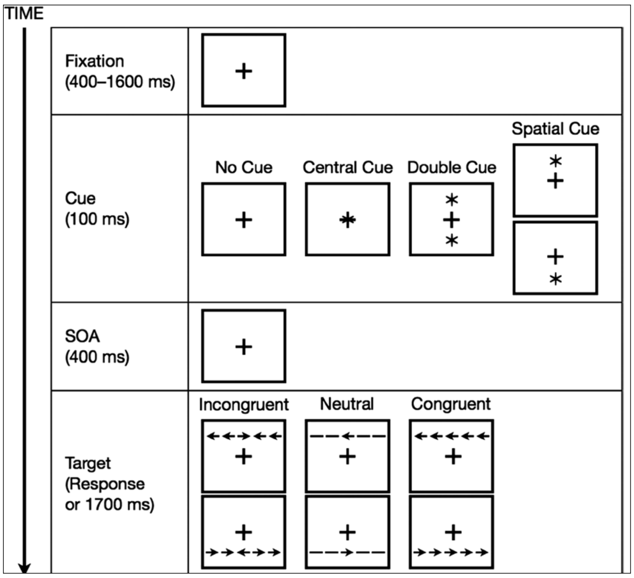

Figure 1. The structure of a trial in the ANT. Reprinted from MacLeod, J. W., Lawrence, M. A., McConnell, M. M., Eskes, G. A., Klein, R. M., & Shore, D. I. (2010). Appraising the ANT: Psychometric and theoretical considerations of the Attention Network Test. Neuropsychology, 24(5), 637–651, Figure 1, with general permission from American Psycjological Association

A participant is informed that an asterisk location in the spatial cue condition predicts the target location, and that the appearance of asterisks in the center cue and double cue conditions indicates that the target will occur soon. The procedure contains a practice block of 24 trials and three experimental blocks of 96 trials each separated by short breaks for a rest. The whole experiment usually takes about twenty minutes to complete.

Calculations based on the mean reaction time (RT) to different types of trials provide measures of efficiency for each attention network. The RT in the double cue condition subtracted from the RT in the no cue condition gives the alerting network score. The RT in the spatial cue condition subtracted from the RT in the center cue condition generates the orienting network score. The RT in the congruent target condition subtracted from the RT in the incongruent target condition gives the executive control network score. Notably, the last index is inverted: the higher it is, the worse the executive control network functions.

According to Posner and Peterson's model (Posner & Petersen, 1990) the three attention networks are independent. Alerting, orienting, and executive control scores of the ANT therefore should not correlate with each other. This is a key issue for testing both the validity of the ANT and Posner's theoretical ideas about attention networks. Fan and his colleagues analyzed the data of 40 participants (Fan et al., 2002) and found no correlation between attention network scores. The only mildly positive correlation was obtained between executive control scores and the grand mean reaction time. This finding indicates that the participants with larger RTs are less efficient in inhibiting irrelevant responses. Of particular interest is the interaction obtained between the types of cues and flankers. This interaction showed a certain degree of dependence between orienting and executive control networks. Evidence obtained in other studies (see MacLeod et al., 2010) confirms that no stable pattern of correlation exists between attention network scores. However, some statistically significant correlations between ANT scores have been found. Moreover, the interaction between cues and flankers is regularly reported by various researchers (e.g., Costa, Hernández, & Sebastián-Gallés, 2008; Fan et al., 2002; Ishigami & Klein, 2009; Redick & Engle, 2006).

To the best of my knowledge, there are no Russian publications on the ANT. The present study has two main goals: (1) to report the data obtained with the ANT in a Russian sample; these data could be regarded as normative for Russian samples, and (2) to add to the literature about the independence of attention networks.

Method

Participants

A total of 82 participants volunteered to participate in the study. Three of them were excluded from the analysis because they made errors in more than 10 percent of trials in the experimental blocks. The final sample consisted of 79 participants (26 men and 53 women) aged from 18 to 34 (mean age = 22.5, *SD* = 3.57).

Procedure

Since the data were collected in the framework of a larger research project, the participants were administered an array of other tasks that are not considered here. The ANT was administered in a standard way as described by its authors (Fan et al., 2002). For running the ANT, the software created by Fan and colleagues was downloaded from the webpage http://www.sacklerinstitute.org/users/jin.fan/.

Results and Discussion

The distributions of all scores were normal according to the Kolmogorov-Smirnov test. For this reason, parametric methods were used in the further statistical analysis.

Means and standard deviations of the attention network scores, along with the grand mean RT, are shown in Table 1. The mean orienting and executive control scores are very similar to those reported in a recent meta-analysis of ANT studies (MacLeod et al., 2010), where the mean orienting score was equal to 42 ms and the mean executive control score was equal to 109 ms. However, the mean alerting score in this meta-analysis was slightly higher: 48 ms.

Table 1 Descriptive statistics and Pearson correlation coefficients between the ANT scores

	M (ms)	*SD*	Alerting	Orienting	Executive control
Alerting	39	23			
Orienting	41	26	.05		
Executive control	113	33	−.02	.29**	
Grand mean RT	580	76	−.06	.30**	.41**

** Note. $p < .01$.

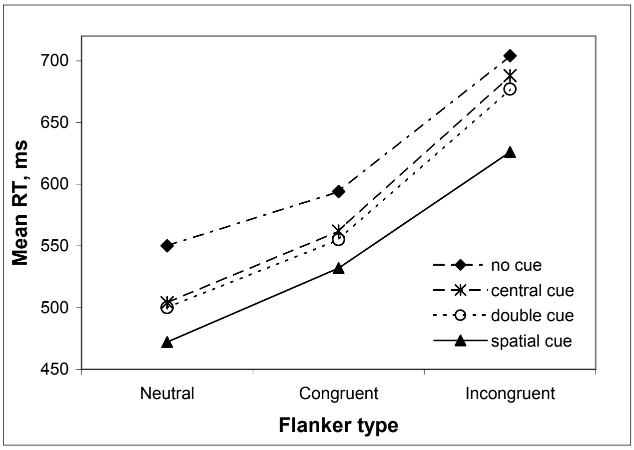

Figure 2. Mean reaction time (RT) for each combination of cue and flanker type.

Inter-network correlation analysis showed a low but statistically significant correlation between orienting network scores and executive control network scores (see Table 1). These two network scores also correlate positively with the grand mean RT. Therefore, better functioning of the orienting network is associated with worse functioning of the executive control network; slower participants are better in orienting and worse in executive control.

These results correspond to those of other studies in the sense that the attention networks may provide various correlation patterns and the correlations are never high. Presumably, the unsteady correlation between the attention networks depends on the physical conditions of the experiment or other situational factors.

A 4×3 (4 cue types × 3 flanker types) repeated-measures analysis of variance (ANOVA) was conducted as another method for testing the independence of attention networks. The results are presented in Figure 2. There were main effects of cue type ($F(3, 234) = 197.317$, $p < .001$, $\eta^2 = .10$) and flanker type ($F(2, 156) = 484.114$, $p < .001$, $\eta^2 = .75$). Critically, there was a significant interaction between the cue type and flanker type ($F(6, 468) = 9.\ 585$, $p < .001$, $\eta^2 = .01$) such that incongruent flankers increased RTs for any cue conditions. This interaction was stronger for the center and double cues.

The ANOVA results completely correspond to the evidence obtained by other researchers (Fan et al., 2002; MacLeod et al., 2010) and indicate that the orienting and executive control networks are interrelated. The same interaction between the types of cues and flankers is replicated in most studies. This allows us to claim that the orienting and executive control networks are not independent, at least, when they are measured by the ANT.

Another important result of the ANOVA concerns the significant difference in RTs to the targets with neutral and congruent flankers. The authors of the ANT did not obtain such a difference and claimed that executive control scores can be calculated by using RT either in the congruent or in the neutral target conditions interchangeably. However, it makes sense to calculate two separate executive control scores for the congruent and neutral target conditions, because these two indices allow a more diverse and rich analysis of attention network functioning.

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краткие сообщения

Опыт применения методики ANT на русской выборке: проверка независимости систем внимания

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Аннотация. Методика ANT (*Attention Network Test*) позволяет измерить функционирование трех систем внимания, выделяемых Познером и Петерсоном (Posner, Peterson, 1990): бдительности, ориентировки и исполнительного контроля. Эта методика стала широко применяться благодаря своей простоте, относительной краткости и доступности для исследователей. В настоящем исследовании сообщаются данные, собранные с помощью ANT на русской выборке. Анализ данных был сосредоточен на проблеме независимости систем внимания. Показано, что ориентировка и исполнительный контроль не являются независимыми друг от друга. Об этом свидетельствует значимая корреляция между ними, а также взаимодействие между различными типами подсказок и флангов в стимульном материале.

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Ключевые слова: методика ANT, бдительность, ориентировка, исполнительный контроль

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