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Need for cognitive closure and attention allocation during multitasking: Evidence from eye-tracking studies

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ABSTRACT

In two studies, we examine how need for cognitive closure (NFC), referring to an individual's tendency to reduce uncertainty via rigid processing style, relates to the way attentional resources are distributed while multitasking. Previous studies show that NFC is related to focused, rather than distributed, attention. High NFC individuals should thus process tasks serially rather than in parallel. That is, in order to maintain performance on an additional task, they would need to shift attentional focus to this task more often. Low NFC individuals, on the other hand, should be able to process both tasks in parallel, i.e. they would maintain performance on the additional task with fewer attentional shifts. To test our hypotheses, we asked participants to perform a main and additional task simultaneously. During task performance participants' eyes were tracked. In line with our predictions, the interest area analysis showed that NFC was related to more fixations and longer dwell time on the additional task. It was also associated with more runs to this task (Studies 1 and 2). The effects were stronger in difficult, compared to easy, condition (Study 2). The paper is the first one to directly test attention allocation during multitasking depending on NFC levels.

1. Introduction

The issue of multitasking is that of effective division and deployment of attentional resources (Courage, Bakhtiar, Fitzpatrick, Kenny, & Brandeau, 2015; Rothbart & Posner, 2015). This issue has become especially important in recent years which have seen a development of modern technology platforms that enable and amplify multitasking (Adler & Benbunan-Fich, 2012; Courage et al., 2015; Cardoso-Leite, Green, & Bavelier, 2015). Nowadays people multitask at home, at school and at work (Bühner, König, Pick, & Krumm, 2006; Hambrick, Oswald, Darowski, Rench, & Brou, 2010). Therefore, more and more studies are conducted to identify individual differences that characterize those who can effectively divide their attention between several ongoing tasks. And so, the role of cognitive factors, such as attention (e.g., Arrington & Yates, 2009; Rothbart & Posner, 2015), executive control (e.g., Heyder, Suchan, & Daum, 2004; Thoma, Koch, Heyder, Schwarz, & Daum, 2008) and working memory (e.g., Bühner et al., 2006), has been emphasized. But there are also motivational variables, such as polychronicity, i.e. preference for multitasking, that predict successful multitasking performance across the range of tasks and occupations (Kantrowitz, Grelle, Beaty, & Wolf, 2012; see König & Waller, 2010, for overview). So, both motivation and cognitive abilities seem to play a significant role in predicting performance on multiple simultaneous tasks. In this paper, we focus on a variable that lies on the juncture of the two fields, namely need for cognitive closure (NFC, Kruglanski, 1989). As a basic motivational tendency to reduce uncertainty and ambiguity, NFC leads to a cognitively rigid processing style and corresponds to differences in elementary cognitive processes (see Kruglanski & Webster, 1996, and Roets, Kruglanski, Kossowska, Pierro, & Hong, 2015, for overview).

There is also research showing that NFC is related to multitasking performance. A study by Szumowska and Kossowska (2016) has demonstrated that high NFC levels are associated with poorer performance on two concurrent tasks, but only for participants low on shifting ability. For high shifting ability participants, high NFC levels were not accompanied by performance decrements. The authors attributed this poorer performance to the limited resource pool and higher selectivity and focalization of attention individuals high on NFC have been shown to exhibit (Kossowska, 2007a, 2007b). These attentional differences, however, have not been directly tested. Also, there is no evidence on how individuals deploy their attention while multitasking depending on their NFC levels.

In this paper, we examine NFC related differences in allocation of attention during multitasking with the use of eye-tracking technique, the direct and unambiguous measure of an overt attention (Blair, Watson, & Walshe, 2009; Hutton, 2008). Based on previous studies (Kossowska, 2007a, 2007b) we assumed that high NFC individuals have a greater focus (narrower scope) of attention, whereas low NFC individuals have a distributed (wider scope of) attention. Since attentional resources of high NFC individuals are concentrated on a narrower area

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of the visual field, not all displayed tasks fall under the scope of attention. Hence, serial, rather than parallel, strategy of processing of multiple tasks needs to be adopted. This suggests that high NFC individuals will not be able to maintain performance on an additional task without shifting attentional focus to it. By contrast, low NFC individuals will be able to perform both tasks in parallel without frequent shifts of attentional focus between two ongoing tasks.

The paper is the first one to directly test how attention is divided between several ongoing tasks depending on NFC levels. It might thus account for differences in multitasking performance demonstrated in other studies (Szumowska & Kossowska, 2016, 2017). It also adds to the theory of NFC by providing further insight into NFC related differences in cognitive abilities. From a broader perspective, it taps into a question on how motivation affects performance in general, and multitasking performance in specific.

2. Need for closure and differences in attention

Attention is a major mechanism of visual selection developed to protect people from being overloaded by a huge quantity of information from the environment (Facoetti, Paganoni, & Lorusso, 2000; McMains & Somers, 2004). Since the capacity of visual cognition is limited, an effective visual selection mechanism is required. Thus, stimuli that are relevant to performing important tasks and ongoing actions are selected, whereas irrelevant elements are excluded (Blair et al., 2009; Simons, 2000; Treisman & Gelade, 1980; Wolfe, 2003). This task is supported by eye movements which coordinate attention to areas that are relevant for a given goal in order to attain it, thus facilitating processing in a particular area of the visual field.

To capture its selective function, visual attention has often been described as a spotlight (Broadbent, 1982; Eriksen & Hoffman, 1973; Posner, 1980; Yantis, 1988), filter channel (LaBerge & Brown, 1989), zoom lens (Eriksen & St. James, 1986; Eriksen & Yeh, 1985) and distribution of processing resources (Downing & Pinker, 1985; Kahneman, 1973; Shaw, 1978). Despite many differences, all these models imply that attentional resources can be concentrated in a small portion of a visual field or rather diffusely distributed over it (Facoetti et al., 2000; see also Treisman, 2006). So, two modes of visual information processing can be identified, that is distributed (diffused) and focused (concentrated) attention (Bergen & Julesz, 1983; Duncan, 1980; Jonides, 1983; Schneider & Shiffrin, 1977; Srinivasan, Srivastava, Lohani, & Baijal, 2009). In the focused mode, attentional resources are concentrated in one area of the visual field where the stimulus is expected to appear (often a precued location). As most resources are concentrated on a single location, information is analyzed sequentially but with faster speed. By contrast, in the distributed mode, the focus of attention dominates all possible display locations and attentional resources are diffusely activated in the visual field. This mode permits parallel processing of information in the whole perceptual field, but at a low processing speed (Facoetti et al., 2000; the fact that spatial attention can be divided and oriented, in parallel, to two or more regions of the visual field has also been argued by others, e.g., Baldauf & Deubel, 2007; Cavanagh & Alvarez, 2005; Castiello & Umiltà, 1992; Godijn & Theeuwes, 2002; Kramer & Hahn, 1995; McMains & Somers, 2004; Müller, Malinowski, Gruber, & Hillyard, 2003; Shaw, 1978).

Some authors argue that, instead of modes, attentional distribution in the visual field should be treated as a continuum (Eriksen & Yeh, 1985). On one pole of the continuum, attentional resources are uniformly distributed over the entire effective visual field. On the other, they are focused on a very small area. Which mode (or point on the continuum) is activated depends on the stage of attentional distribution (Jonides, 1983) as well as the task context (Eriksen & Yeh, 1985; Jonides, 1983). However, there are stable individual differences as to whether a focused or distributed attention is default and dominant. In support of that, Facoetti et al. (2000) showed that dyslexics exhibited a diffused distribution of visual processing resources compared to their non-dyslexic counterparts. Similar was found for dysphoric individuals who were argued to have unfocused and unselective attention allowing to acquire more information from the periphery of the ongoing task (Brzezicka, Krejtz, von Hecker, & Laubrock, 2012; Von Hecker & Meiser, 2005). Also, differences in division of attention between extraverts and introverts (Szymura, 2010), as well as individuals high and low on psychoticism (Szymura, Śmigasiewicz, & Corr, 2007) have been reported.

Attentional differences have also been found in relation to NFC. It is well documented that this variable is linked to more structured, rigid, and persistent cognitive styles (Kruglanski & Webster, 1996; Roets et al., 2015). Individuals high on NFC have been found to be less flexible, less creative, more narrow-minded, and more motivated to bring information processing to a close by leaping to a conclusion (Kruglanski, Dechesne, Orehek, & Pierro, 2009). Previous studies have also shown that the typical effects of NFC, such as simplification, structuring, and reduction of information, might stem from certain cognitive deficits, such as a restricted pool of cognitive resources allocated to a current activity (Kossowska, 2007a, 2007b). Specifically, high NFC individuals exhibited a slower working memory search, suggesting that they may have a lower capacity to perform cognitive operations on a current task (Kossowska, Orehek, & Kruglanski, 2010). Previous research also shows that high (vs. low) NFC individuals possess more limited cognitive resources or 'processing capacity' as measured with random interval generation task (Kossowska, 2007b). However, these cognitive limitations can be compensated for by a particularly efficient process of information selection from the environment (Kossowska, 2007b; Pica, Pierro, Belanger, & Kruglanski, 2013) and a greater ability to efficiently handle distractors (Kossowska, 2007a). In line with that, Kossowska et al. (2015) have shown that higher levels of NFC are related to more attention allocated to the selected stimuli or the feature of the stimuli at early stage of processing.

The above indicates that NFC is related to a focused, rather than distributed, attention. In fact, many studies have shown that high NFC is associated with an increased focus or 'freeze' on a specific part of the cognitive field (e.g. on specific categories or concepts, Kossowska, 2007a; Kruglanski & Webster, 1996), which might lead to effects such as the tendency to adhere to prior opinions (Kruglanski, Webster, & Klem, 1993), assimilate judgments to primed constructs (Ford & Kruglanski, 1995), pursue narrow goals that turn attention away from discrepancies (Kruglanski et al., 2009) and focus on an ingroup as a source of one's social reality (De Grada, Kruglanski, Mannetti, & Pierro, 1999). It might also translate into how people allocate their attentional resources in the perceptual field, i.e. how they divide attention between several ongoing tasks.

3. Need for closure and multitasking performance

Multitasking requires division of attention between several ongoing tasks (Judd, 2013) and/or frequent switches between them (Monsell, 2003). Since individuals high on NFC have a focused rather than distributed attention, they should be more prone to concentrate their attentional resources on a single location of the visual field (one task), rather than simultaneously follow all displayed tasks. The latter should be the case for low NFC individuals whose distributed attention would make parallel processing possible. In other words, since high NFC individuals' attentional scope is narrow and covers smaller area of the visual field, they should process task-relevant information serially rather than in parallel. This suggests that they should switch between ongoing tasks (shift attentional focus from one task to another) more often in order to efficiently perform the tasks at hand. By contrast, low NFC individuals' wider scope of attention should cover the entire display allowing simultaneous processing of multiple tasks, i.e. less switches should be required to ensure efficient performance on simultaneous tasks.

The above also implies that, although multitasking might be more difficult for high, compared to low, NFC individuals, efficient performance on concurrent tasks might be possible with frequent shifts of