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Need for closure and cognitive flexibility in individuals with autism spectrum disorder: A preliminary study

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ABSTRACT

The need for closure (NFC), a desire for a firm answer and less ambiguity, has a key role in cognitive flexibility in typical development (TD) populations. This study investigated this motivational construct and its relation to cognitive inflexibility in autism spectrum disorder (ASD). Compared with individuals with TD, those with ASD reported higher levels in preference for predictability and closed-mindedness and lower levels in decisiveness. These NFC facets were significantly associated with cognitive flexibility in ASD as well as TD groups. The study findings provide further insights into the motivational underpinnings of flexible behavior in ASD.

1. Introduction

Humans are constantly exposed to socially conflicting situations in everyday life, and cognitive flexibility, which is the ability to switch between thinking about different and multiple concepts simultaneously, is necessary for adaptive coping (Champagne-Lavau et al., 2012; Tei et al., 2018a). Individuals with autism spectrum disorder (ASD) have cognitive inflexibility (Fujino et al., 2017a, b; Van Eylen et al., 2011), which negatively affects their social functioning. Individuals' levels of cognitive flexibility are known to be influenced by several factors, such as their levels of cognitive/emotional intelligence and social skills (Crone and Dahl, 2012; Tei et al., 2017). In addition, motivational factors can influence flexible behavior (Roets et al., 2015), which has received relatively limited attention in research on ASD.

Need for closure (NFC) is defined as a desire for a firm answer to a question and an aversion to ambiguity (Kossowska et al., 2015; Kruglanski et al., 1993). This motivational construct was developed in the psychosocial area of psychology. When elevated, it is known to truncate the consideration of further relevant evidence and to promote the formation of inflexible judgments (Bentall and Swarbrick, 2003; Roets et al., 2015). Thus, heightened NFC fosters cognitive inflexibility, which manifests as insensitivity to subsequent information and resistance to change (Combs et al., 2007; Kossowska et al., 2015). Recent neuroimaging research has confirmed this notion by showing that reduced flexibility in subjects with high NFC was mediated by decreased corticocortical connectivity among brain regions [inferior frontal gyrus (IFG) and dorsolateral prefrontal cortex (DLPFC)], which are crucial for adaptation to behavioral conflict during tasks related to cognitive flexibility (Roets et al., 2015; Viola et al., 2014). NFC has also been shown to influence teaching and learning styles, and the assessment of NFC provides useful information for designing individualized effective intervention strategies in educational settings (DeBacker and Crowson, 2009; Roets et al., 2015).

Considering the demonstrated contribution of NFC to the

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understanding of cognitive flexibility and the development of effective individualized education programs in typical development (TD) populations, it might be relevant to investigate this motivational construct in individuals with ASD, in whom cognitive inflexibility is a recognized problem. The concept of NFC resonates clinically with some of the core characteristics of ASD, such as inflexible adherence to specific routines, insistence on ritualistic/sameness behavior, and difficulty tolerating unexpected changes (Boulter et al., 2014; Robic et al., 2015; Zimmerman et al., 2017). The clinical presentation of the symptoms of ASD is heterogeneous across individuals with ASD (Tsatsanis, 2004; Fujino et al., 2017a). In addition, previous studies have shown that ASD forms a continuum which can extend into typical population (Geurts et al., 2013; Nummenmaa et al., 2012). These research findings and clinical observations suggest that the examination of the relevance of NFC in cognitive inflexibility could improve our understanding of this ability and provide useful information when designing individualized educational/therapeutic programs in individuals with ASD. However, to our knowledge, no study has directly investigated NFC in individuals with ASD or its association with cognitive inflexibility.

We used the Cognitive Flexibility Scale (CFS) to measure cognitive flexibility. A large number of studies have used the CFS to assess cognitive flexibility (Curran and Andersen, 2017; Fujino et al., 2017b), and its usefulness for assessing the impairment of this ability in various psychiatric disorders including ASD has also been reported (Lee and Orsillo, 2014; Okuda et al., 2017). We used the NFC scale to assess NFC. This scale was developed by Webster and Kruglanski (1994), which has five facets: preference for order, preference for predictability, decisiveness, discomfort with ambiguity, and closed-mindedness. Preference for order is related to the desire for a definite order and structure in life and the aversion to unconstrained chaos and disorder. Preference for predictability is related to the trans-situational-consistency implication of secure knowledge, affording predictability to future contexts. Decisiveness is related to the urgency of striving for closure in judgment and decision-making. Discomfort with ambiguity is related to the affective discomfort occasioned by ambiguity, i.e., the absence of closure. Closed-mindedness is related to the desire for secure closure, i.e., an unwillingness to have one's knowledge confronted.

In this study, we first compared the CFS and NFC scale scores between the TD and ASD groups. In recent decades, a considerable amount of NFC scale research has been conducted, and its multidimensionality has been reported (Roets et al., 2015). Accordingly, it has been proposed that the sole use of NFC scale total scores would mask the complex and significant relationships (Colbert et al., 2006; McKay et al., 2006). Thus, we compared each facet score (preference for order, preference for predictability, decisiveness, discomfort with ambiguity, and closed-mindedness) as well as the total score between the groups. Subsequently, we investigated the relationship between the NFC scale total/each facet score and the CFS score in the TD and ASD groups, respectively. Based on the previous evidence that the ASD characteristics lie on a continuum that extends into the typical population (Geurts et al., 2013; Nummenmaa et al., 2012), it was hypothesized that similar relationship between the NFC scale and CFS scores would be observed across the ASD and TD groups.

2. Methods

2.1. Participants

The study included 28 adults with ASD and 28 with TD (age range: 20–45 years). The ASD diagnostic procedure was the same as that in our previous studies (Fujino et al., 2017a; Itahashi et al., 2015). Briefly, at least three experienced psychiatrists and a clinical psychologist assessed all participants using the criteria of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition text revision (DSM-IV-TR). The assessment involved participant interviews about developmental history, present illness, life history, and family history. Participants were asked to bring suitable informants who had known them in early childhood. The entire process required approximately 3 h. A diagnosis of ASD was made only when there was a consensus among the psychiatrists and clinical psychologist. Participants with TD did not meet the criteria for any psychiatric disorders according to the evaluation of an experienced psychiatrist, using the Structured Clinical Interview for DSM-IV Axis I Disorders. No participants (ASD or TD) had any history of a serious medical or surgical illness, or illegal substance abuse. Further details are provided in Supplementary Methods.

The intelligence quotient (IQ) scores of all participants with ASD had been evaluated before the study using either the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) or the WAIS-Revised (WAIS-R). Each participant with ASD was considered high functioning, as the full-scale IQ score was above 80. The IQ scores of participants with TD were estimated using the Japanese version of the National Adult Reading Test (JART), as the JART has been shown to successfully predict the full-scale IQ score in a healthy population (Matsuoka et al., 2006; Matsuoka and Kim, 2006). All participants completed the Autism-Spectrum Quotient test (Baron-Cohen et al., 2001; Wakabayashi et al., 2006).

This study was approved by the Committee on Medical Ethics of Kyoto University and the institutional review board of Showa University Karasuyama Hospital, and it was conducted in accordance with The Code of Ethics of the World Medical Association. Written informed consent was obtained from all participants. This study is a part of a larger project aimed at social cognition in individuals with ASD, and participants completed a range of measures, not all of which are reported here.

2.2. Measures

2.2.1. Need for closure scale

To measure NFC, we used the NFC scale (Kruglanski et al., 1993; Tanaka et al., 2015; Webster and Kruglanski, 1994), which comprises 42 items and involves the following five facets: preference for order [10 items (e.g., “I think that having clear rules and order at work is essential for success”)]; preference for predictability [8 items (e.g., “I don't like to go into a situation without knowing what I can expect from it”)]; decisiveness [7 items (e.g., “I usually make important decisions quickly and confidently”)]; discomfort with ambiguity [9 items (e.g., “I'd rather know bad news than stay in a state of uncertainty”)], and closed-mindedness [8 items (e.g., “I do not usually consult many different opinions before forming my own view”)]. Participants were asked to indicate their agreement with a statement on a 6-point scale [1 (strongly disagree) to 6 (strongly agree)]. We adopted the NFC scale that had already been used for a Japanese population in the previous study (Tanaka et al., 2015). Higher scores indicate greater NFC.

2.2.2. Cognitive flexibility scale

To assess cognitive flexibility, we used the CFS, which examines individual flexible choice tendencies (Martin and Rubin, 1995). The CFS is a self-reported scale comprising 12 items (e.g., “I can communicate an idea in many different ways” and “I am willing to work at creative solutions to problems”), with each rated on a 6-point Likert scale. It evaluates an individual's awareness of alternative ways of behaving and the willingness and perceived ability to be flexible. The CFS-Japanese version (CFS-J) (Oshiro et al., 2016) was used. Higher scores indicate greater cognitive flexibility.

2.3. Statistical analysis

The NFC scale total/facet and CFS scores were compared between the TD and ASD groups using two-sampled *t*-tests. We performed correlation analyses between the NFC scale total/each facet score and the CFS score within each group. Finally, the homogeneity of the slopes of linear regression obtained from these correlation analyses were tested

between the two groups. This aimed to identify potential differences in the relationship between NFC and cognitive flexibility between individuals with ASD and those with TD. To this end, based on the previous studies (Kubota et al., 2011; Fujino et al., 2016), a multiple regression model was applied to detect the effects of the NFC scale-diagnosis interaction on CFS. The dependent variable was the CFS score, while the independent variables were the NFC scale total/each facet score, diagnosis, and their interactions (we analyzed separately for the NFC total/each facet score). Data were analyzed using SPSS 21 (IBM Corp., Armonk, NY, USA). Statistical significance was set at a p-value < 0.05 (two-tailed). Because of the exploratory nature of this study, no correction was applied for multiple comparisons. However, results considering Bonferroni correction for multiple testing were also reported.

3. Results

The TD and ASD groups were matched in terms of age, sex, current smoking status, and estimated full-scale IQ levels (Table S1). The smoking status has been reported to be associated with social cognition and decision-making (Lejuez et al., 2003).

As expected, the CFS score was significantly lower in the ASD group than in the TD group (TD, 48.9 ± 8.6 and ASD, 36.6 ± 8.0; $p < 0.001$). With regard to NFC, there were no significant differences between the groups regarding the total scores of the NFC (TD, 149.9 ± 16.0 and ASD, 157.6 ± 15.0; $p = 0.07$). However, on the comparison of the NFC scale facets, the ASD group showed significantly higher scores of preference for predictability (TD, 26.6 ± 6.1 and ASD, 35.3 ± 6.3; $p < 0.001$) and closed-mindedness (TD, 23.5 ± 5.3 and ASD, 26.8 ± 4.7; $p = 0.02$) but showed a significantly lower decisiveness score (TD, 26.5 ± 6.6 and ASD, 18.9 ± 5.6; $p < 0.001$). There were no significant differences in the preference for order and discomfort with ambiguity scores between the groups (both, $p > 0.13$) (Table S2). The difference in the closed-mindedness score between the groups was not significant after Bonferroni correction [p corrected = 0.0071 (0.05/7)].

The scores of the three abovementioned facets that significantly differed between the groups (i.e., preference for predictability, closed-mindedness, and decisiveness) showed significant correlations with the CFS scores in the TD and ASD groups. Specifically, the scores of preference for predictability and closed-mindedness were both negatively correlated with the CFS scores [preference for predictability: TD, $r = -0.68$ ($p < 0.001$) and ASD, $r = -0.41$ ($p = 0.03$); closed-mindedness: TD, $r = -0.50$ ($p = 0.007$) and ASD, $r = -0.61$ ($p < 0.001$)], and the decisiveness score was positively correlated with the CFS scores [TD, $r = 0.67$ ($p < 0.001$) and ASD, $r = 0.38$ ($p = 0.048$)] in both groups (Fig. 1). The total NFC scores or those of the other two facets were not significantly correlated with the CFS scores in both groups (all, $p > 0.07$, Table S3). The correlations between the CFS score and closed-mindedness score in the TD group and those between the CFS score and preference for predictability and decisiveness scores in the ASD group were not significant after Bonferroni correction [p corrected = 0.0042 (0.05/12)].

Finally, using a multiple regression model, the homogeneity of the slopes of linear regression obtained from these correlation analyses were tested between the two groups. We did not find any significant interactions between the NFC scale (total score or each facet score) and diagnosis on CFS (all, $p > 0.12$), indicating that the regression lines between the NFC scale total/each facet score and the CFS score did not significantly differ between the two groups. Please see Table S4 for details.

4. Discussion

To our knowledge, this is the first study to investigate NFC and its relationship with cognitive flexibility in individuals with ASD.

As expected, the CFS scores were lower in the ASD group than in the TD group. The results indicate that individuals with ASD have difficulty in flexible decision-making, which is consistent with the findings of previous studies (Okuda et al., 2017; Tei et al., 2018b; Van Eylen et al., 2011).

With regard to NFC, the preference for predictability score was higher in the ASD group than in the TD group. In addition, to a lesser extent, the score of closed-mindedness was higher in the ASD group than in the TD group (no significance after Bonferroni correction). These findings indicate that individuals with ASD had an increased desire for secure and stable knowledge, which was reliable across circumstances and unchallenged by exceptions, and that they were less receptive to alternative opinions or inconsistent evidence. Our findings are consistent with the clinical image of ASD, including the tendency to engage in repetitive behavior and experience social-interaction difficulties (Corbett et al., 2009; Rodgers et al., 2017; Sanders et al., 2008), and provide further insights into the motivational underpinnings of knowledge information, judgment, and decision-making in this patient group.

Conversely, the decisiveness score was lower in the ASD group than in the TD group. A previous study examining the jumping-to-conclusions beads task, which measures how many beads a participant requests before making a decision, showed that the number of beads required before making decisions was higher in individuals with ASD than in controls (Brosnan et al., 2014). Furthermore, several studies using the NFC scale found that the decisiveness facet had low and even negative correlations with other facets (Roets et al., 2015). The current results are consistent with the notion of circumspect bias in ASD (Brosnan et al., 2014), and suggest that reduced decisiveness may lead to dysfunctional social behavior.

Although the preference for predictability and closed-mindedness scores were higher and the decisiveness score was lower in the ASD group than in the TD group, the distributions of these NFC scale facet scores were diverse in both the ASD and TD participants. This observation is consistent with the results of previous studies showing that there are large individual differences in the NFC score in TD populations (Kruglanski and Webster, 1996; Roets et al., 2015), and our findings suggest that such individual differences can also be seen in ASD populations. The elucidation of the heterogeneity of symptom expression in ASD is crucial for obtaining a better understanding of the underlying neurobiological mechanisms, as well as establishing precise treatment strategies (Fujino et al., 2018; Keefer et al., 2017; Tei et al., 2018b). Although this was a preliminary study with a small sample, the results may help elucidate some aspects of heterogeneity in ASD and improve the specificity of individualized interventions.

The scores of preference for predictability, closed-mindedness, and decisiveness were significantly correlated with the CSF scores in both groups; however, some of these correlations were not significant after Bonferroni correction. In addition, the regression lines between the NFC scale total/each facet score and the CFS score did not significantly differ between the two groups. The equivalence of the relationship between NFC and cognitive flexibility across diagnostic groups suggests that similar processes are at work within both populations and that the NFC facets, i.e., preference for predictability, closed-mindedness, and decisiveness, are important constructs for cognitive flexibility in ASD as well as TD populations.

We did not find significant differences in the total NFC scale scores between the groups. In addition, the total NFC scale scores did not significantly correlate with the CFS scores in both ASD and TD groups. In recent decades, a considerable amount of NFC scale research has been conducted, and its multidimensionality has been reported (Roets et al., 2015). Accordingly, it has been proposed that the sole use of NFC scale total scores would mask the complex and significant relationships (Colbert et al., 2006; McKay et al., 2006). Our findings are in line with this notion and highlight that NFC is not a unitary but a multifaceted construct in relation to cognitive flexibility.

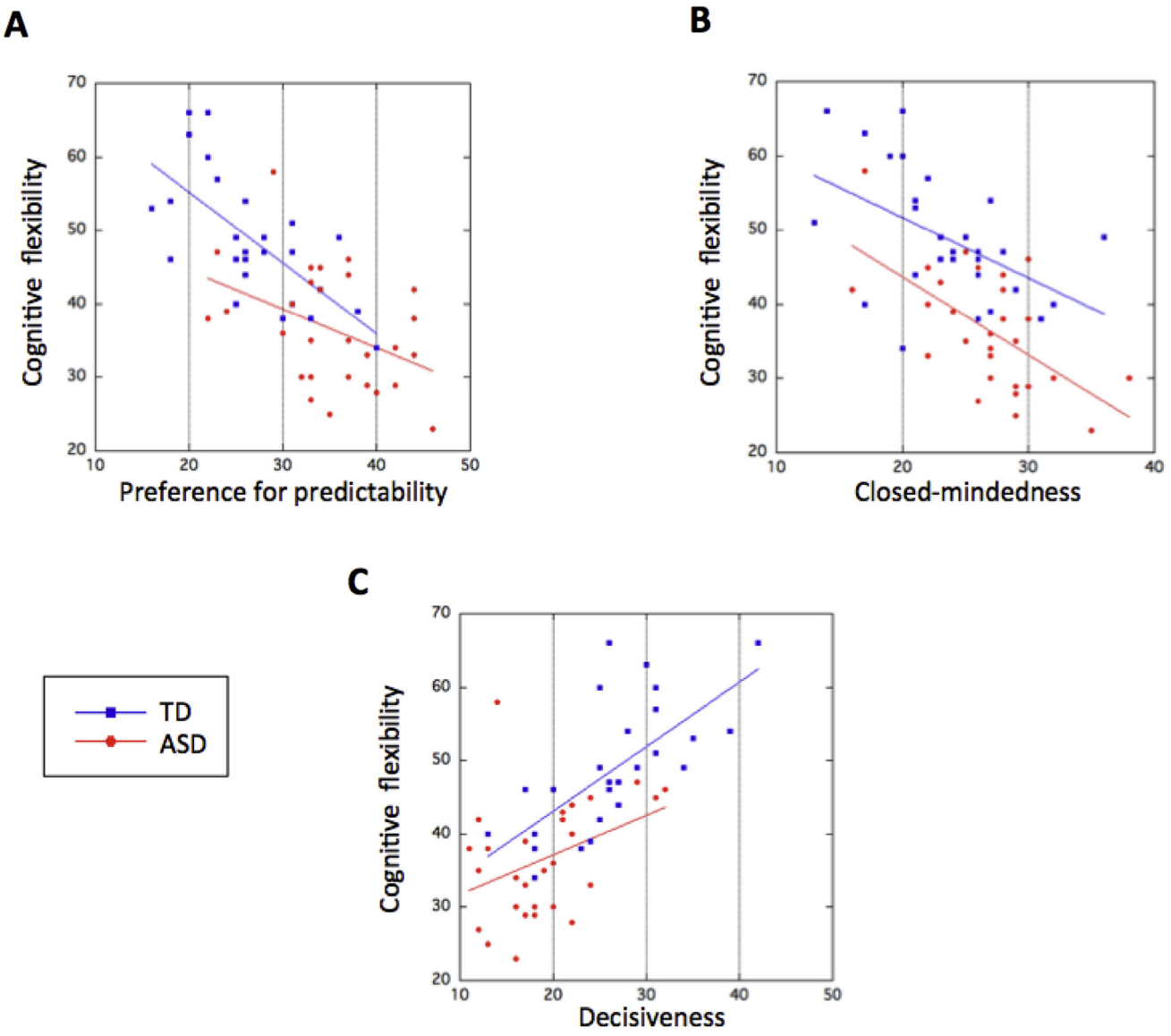

Fig. 1. Correlations between need for closure facets and cognitive flexibility. Correlations between need for closure scale facet scores and cognitive flexibility scale (CFS) scores among individuals with typical development (TD) and autism spectrum disorder (ASD). (A) Correlation between preference for predictability and CFS scores [TD, $r = -0.68$ ($p < 0.001$) and ASD, $r = -0.41$ ($p = 0.03$)]. (B) Correlation between closed-mindedness and CFS scores [TD, $r = -0.50$ ($p = 0.007$) and ASD, $r = -0.61$ ($p < 0.001$)]. (C) Correlation between decisiveness and CFS scores [TD, $r = 0.67$ ($p < 0.001$) and ASD, $r = 0.38$ ($p = 0.048$)].

Considering the potential conceptual overlap, it can be argued that the association found between NFC scale facet and CFS scores in the ASD group may have been related to the measure of NFC capturing the clinical features of ASD rather than true NFC. However, the equivalence of the relationship between NFC and cognitive flexibility across participants with ASD and those with TD indicates the presence of similar processes in both groups. This is contrary to the idea of a significantly different construct being measured in the ASD group.

The results of the present study have some implications. Intriguingly, we observed fairly similar relationship between the NFC facets (preference for predictability, closed-mindedness, and decisiveness) and CFS across groups. This suggests that these NFC scale facets may be used as a continuous parameter of cognitive inflexibility for both TD and ASD. A recent functional magnetic resonance imaging study has shown that reduced flexibility in subjects with high NFC is mediated by decreased corticocortical connectivity between the IFG and DLPFC, which have been repeatedly reported to be altered in individuals with ASD (Roets et al., 2015; Viola et al., 2014; Philip et al., 2012). Our findings will provide an impetus for future neuroimaging studies, together with a NFC framework, for a deeper understanding of inflexible behavior.

The present study has several limitations. First, because of the exploratory nature of this study, no correction was applied for multiple comparisons. Additionally, some of the significant results were not significant after applying Bonferroni correction. Thus, our preliminary findings should be interpreted cautiously, and they need to be carefully explored and replicated in large-scale future research. Second, our ASD sample included only high-functioning individuals with ASD. Future studies that recruit ASD individuals with diverse IQ levels are needed to strengthen our findings. Despite these limitations, this study offers further insights into the motivational underpinnings of flexible behavior by illustrating that the NFC facets, i.e., preference for predictability, closed-mindedness, and decisiveness, may be important constructs for cognitive flexibility in ASD as well as TD populations.

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Declarations of interest

None.

Authors’ contributions

J.F., S.T., T.I., H.O., M.I., R.H., M.N., N.K., and H.T. designed research; J.F., S.T., T.I., and Y. A. participated in the data acquisition; J.F., Y.A. H.O., M.N., and N.K. were in charge of the clinical assessment. J.F., and S.T. analyzed data; T. I., Y.A. H.O., M.K., M.I., R.H., M.N., N.K., and H.T. helped with interpretation of data. J.F., S.T., T. I., Y.A., H.O., M.K., M.I., R.H., M.N., N.K., and H.T. wrote the paper. All authors have made intellectual contribution to the work and approved the final version of the manuscript for submission.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.11.057.

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