Spatial Pattern Separation and Cognitive Flexibility in High Functioning Autism

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INTRODUCTION

Pattern separation allows us to discriminate between similar events in memory, thus helping reduce interference and enhance memory accuracy. One factor that may contribute to pattern separation function is cognitive flexibility, a type of thinking that involves being able to switch between different concepts as well as simultaneously think about multiple concepts. The hippocampus plays a considerable role in flexible cognition (Rubin et al., 2014), and it has been theorized that low levels of cognitive flexibility, which may behaviorally manifest as being fixated on minute details or rules, may lead to impairments in hippocampal pattern separation (Sahay et al., 2011). Impairments in cognitive flexibility are a common associated deficit observed in autism spectrum disorder (ASD; Leung & Zakzanis, 2014), which suggests that pattern separation may also be compromised in individuals with ASD compared with those who do not have ASD. The current study examined whether young adults with high-functioning ASD (HF-ASD) display altered performance on a spatial pattern separation task and in perceived cognitive flexibility compared to neurotypical young adults.

METHOD

Participants

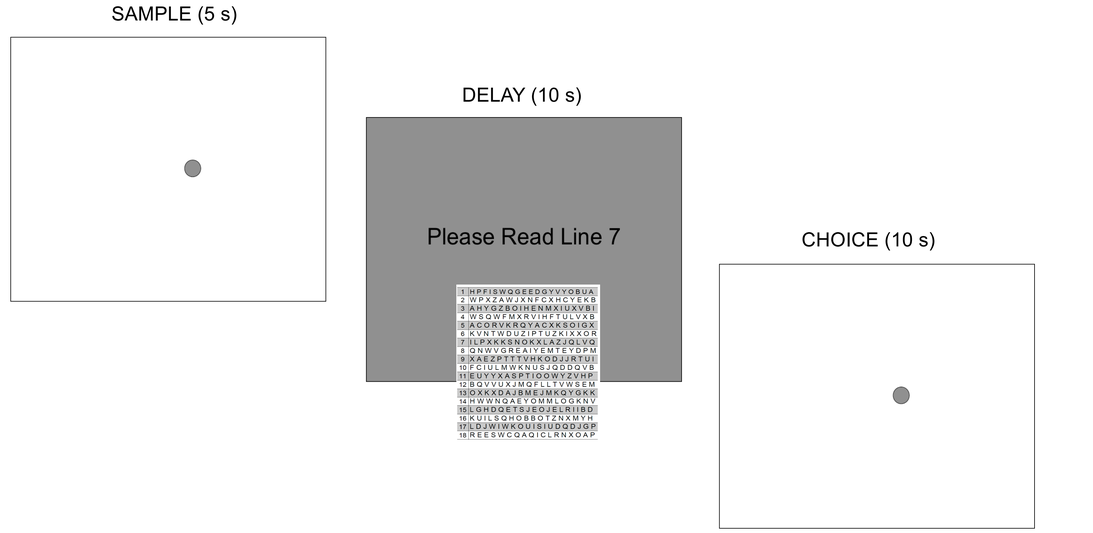
A total of 85 participants, which included 12 HF-ASD (~8% female) and 73 neurotypical adults (~68% female) aged 18 to 26 years old completed the current study. Participants either participated to partially fulfill their General Psychology course requirements (~86%), or were recruited from a clinical participant registry. All participants completed the Cognitive Flexibility Scale and a spatial pattern separation task.

Cognitive Flexibility Scale

A self-report 12-item Likert-type scale (Martin & Rubin, 1995) where participants rated perceptions of their ability to be flexible in their thoughts and actions. Total scores can range from 12 to 72, with higher scores indicating higher cognitive flexibility.

Spatial Pattern Separation Task

This delay match-to-sample task was adapted from Williams et al. (2018) and kindly provided by Dr. Paul Gilbert and colleagues. Participants completed the task through PowerPoint on a computer with a 24-inch monitor surrounded by a 15-cm black border around the screen. Participants were given 72 trials where they judged whether the spatial location of a grey circle appearing on a computer screen during the choice phase was either in the same or different location as the original grey circle that appeared in the sample phase. The spatial location of the circle appearing in the choice phase was either 0, 0.5, 1, 1.5, or 2 cm to the left or right of the original location shown in the sample phase.



Data Analyses

Compared to LARGE separations (1.5 or 2 cm), SMALL separations (0.5 or 1 cm) between the sample and choice phase spatial locations placed greater demands on pattern separation due to the increased potential for memory interference. To control for response biases, task performance was analyzed using standard signal detection theory procedures, which yielded a separate discrimination sensitivity measure (d') for small (high interference) and large (low interference) trials. Higher d' scores indicate higher levels of spatial pattern separation performance.

RESULTS

- Participants overall exhibited higher spatial pattern separation performance in the large separation (low interference) condition compared with the small separation (high interference) condition, F (1,83) = 23.71, p < .001 (Figure 1).
- The HF-ASD group performed significantly lower overall, F (1, 83) = 4.87, p = .03, and within both the large and small separation conditions than neurotypical participants (Figure 1).
- The HF-ASD group also had significantly lower Cognitive Flexibility Scale (CFS) scores than the neurotypical group, t(83) = 3.99, p < .001 (Figure 2).

Figure 1

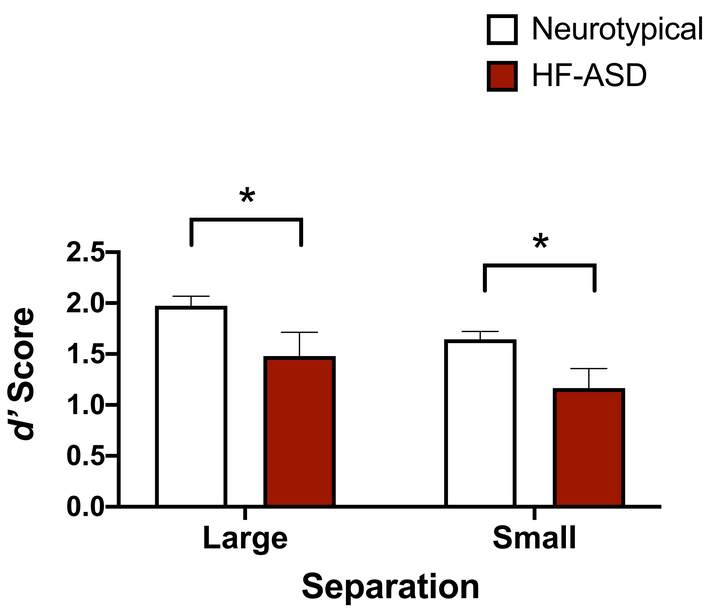
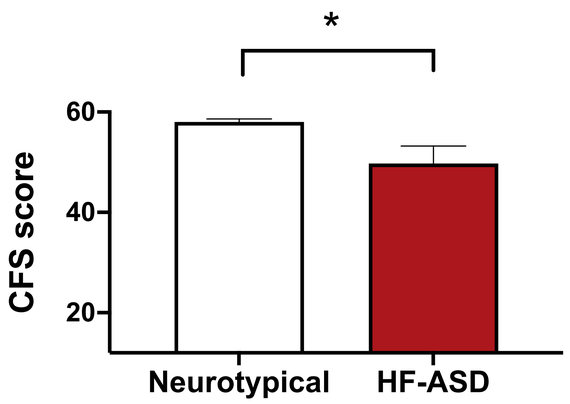


Figure 2



* p < .05; Error bars = SEM

CONCLUSIONS

- Spatial pattern separation ability under conditions of both high and low memory interference are impaired in HF-ASD. This decrement in spatial pattern separation may be linked to decreased cognitive flexibility.
- These findings also support previous studies that revealed impaired pattern separation of objects (South et al., 2015) and impaired recognition memory of visual stimuli (Bowler et al., 2014) in adults with HF-ASD.
- The current findings may also help speak to the development of effective therapies or behavioral interventions targeting these cognitive functions in individuals with ASD.

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