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An Investigation of the Effects of Chronic Stress on Attention in Parents of Children with Neurodevelopmental Disorder

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Abstract

Prolonged exposure to stress can cause impairments in various brain functions including cognition. Attention is one such important cognitive function that is required for our daily life and work-related activities. Chronic stress can have an impact on attention networks such as alerting, executive control, and orienting. The effects of naturalistic, persistent psychosocial stress on several attention networks were explored in this study. Parents of children with neurodevelopmental disorders (NDD) and parents of children with typical development (TD) were given an attention network test (ANT). Overall the stressed group (M= 564.623, SD= 75.484) was found to have a quicker reaction time in all the target and cue conditions when compared to the non-stressed group (M= 588.874, SD= 101.575). Both the groups had similar accuracy in all the conditions. When comparing the three attention network scores, no significant difference was found in both groups. However, in the stressed group, there was a significant beneficial relationship between the alerting and orienting networks (p=.006) and a high negative correlation between the alerting and executive control networks (p=.028). No significant correlation was found between the attention networks in the non-stressed group.

Keywords: Chronic stress, Attention Network, Neurodevelopmental disorders and typical development.

1. Introduction

Stress has been studied for many decades considering its application in various fields of science. These studies have helped us to better understand how psychological processes affect our bodily functions and health (Contrada & Baum, 2010). In simple terms, anything that disturbs the normal functioning of an organism can be called stress (Stokes & Kite, 2000) and the event or the agent that causes stress is known as a stressor. As described by Sapolsky (2004), "a stressor is anything in the outside world that knocks you out of homeostatic balance, and the stress response is what your body does to reestablish homeostasis". According to the transactional model of stress, this response involves a cognitive appraisal which consists of 'perceived threat/demand' (primary appraisal), 'perceived ability and available resources to cope' and the 'perceived importance of being able to cope' (both together as secondary appraisal) (Lazarus, 1966; McGrath, 1976; Lazarus & Folkman, 1984).

At any moment in time our brain can only process limited information (Squire et al., 2012) and it has to choose what stimuli to attend to in order to process it. This "narrowing or focusing awareness selectively to a part of the sensory environment or to a class of stimuli" (Kolb & Whishaw, 2009) is defined as attention. It involves a complex interplay of various brain structures. According to attention network theory, three distinct systems are involved in attention processing, each representing a different component of attention, such as executive control (anterior system), alerting (subcortical system), and orienting (posterior system (Posner, 1992; Posner & Dehaene, 1994). The alerting system is automatic and does not have any cognitive control. It is a primitive attention network involved in the general level of arousal and alerting. The system involves projections from the locus coeruleus which is situated in the brainstem to the forebrain areas like the prefrontal and posterior parietal cortex (Kolb & Whishaw, 2009). The orienting system is involved in prioritising sensory information by selecting a location or modality. It includes dorsal systems including the frontal eye field (FEF), interparietal sulcus (IPS) and temporal-parietal junction (TPJ) (Kolb & Whishaw, 2009). The executive control network is in charge of starting, pausing, and monitoring tasks, as well as resolving conflicts and switching tasks. There are two networks associated with it namely the frontal-parietal network and the cingulo-opercular network.

Prolonged exposure to stress affects attention and cognition both acutely and chronically. In his review, Yaribeygi et al. (2017) described that "the acute effects are mainly caused by the beta-adrenergic effects, while the chronic effects are induced in a long-term manner by changes in gene expression mediated by steroids". Various literature (Staal, 2004; Yaribeygi et al., 2017; Jameison & Dinan, 2001; Andreotti, 2013) shows that mild and acute stress facilitates attention. Attention appears more focused on central tasks and neglects any periphery information while exposed to acute stress. The works of Kohn (1954) also support this property of attention known as tunnelling. Callaway and Dembo (1958) illustrated this tunnelling of attention in emotions like anxiety. However, if the periphery information is important for the ongoing task, tunnelling often lowers the task performance (Staal, 2004).

Various life events can be severe sources of chronic stress in individuals leading to burnout (L. ÖHman et al., 2007). One such source of chronic stress could be caring for family members with conditions such as NDD (Pinquart, 2017). Various studies have found that these are significant sources of chronic stress and have negative effects on their health and cognitive functions (Romero-Martínez et al., 2018; Hayes & Watson, 2012; Dunn, 2001; Bonis, 2016; Nadeem et al., 2016).

Parents of children with ASD experience severe chronic stress in life when compared to normal families (Hayes and Watson, 2012). According to the researchers, the majority of the stress is caused by ASD deficits and impairments such as social communication, restrictive/repetitive conduct, and so on. Also, other social factors were identified as stressors for the parents. The duration of the care and the daily time spent with the individuals have a positive correlation to the intensity of the stress experienced (Romero-Martínez et al., 2018). Also, the severity of the disorder and symptoms are associated with stress levels. Other studies have identified that some parents also undergo spousal problems (Duan et al., 2015) and marital dissatisfaction (DeMyer, 1979) worsening their experiences. The parents of children with NDD experience low social support from others which increases the degree of negative outcomes (Duan et al. 2015). Parents with an external locus of control have higher levels of depression and isolation, showing a difference in the impacts of stress.

2. Materials and Methods

Participants

The present study was included 65 participants both mother of children with NDD and mothers of children with typical development (TD). Mothers of children with NDD were recruited from the outpatients (OP) at the Institute of Mental Health and Neurosciences (IMHANS) hospital who were willing to participate in the study. The non-stressed group included mothers of children with TD, recruited from the OP of the pediatrics department at the Kozhikode District Co-Operative Hospital (KDCH), who matched the age and socio-economic status of the stressed group.

Inclusion and Exclusion Criteria of the Stressed Group

Mothers aged between 25 and 45 with children below 15 years of age who are diagnosed with NDD and scored high in the stress scales were included in the study. Parents who are not active caregivers were not considered. All participants must have (1) no long-term therapeutic glucocorticoid treatments; (2) no history of neuropsychiatric disorders; (3) no hypercortisolism syndromes like Cushing's syndrome; (4) no history of neurological disorders (5) no use of medication known to affect cognition.

Inclusion and Exclusion Criteria of the Non-stressed Group

Mothers of TD children who matched the characteristics (age group and socioeconomic status) of the stressed group were included in the study. Parents who are not active caregivers were not considered. All participants must have (1) no history of neurological disorders; (2) no history of neuropsychiatric disorders; (3) no hypercortisolism syndromes like Cushing's syndrome; (4) no long-term therapeutic glucocorticoid treatments; (5) no use of medication known to affect cognition.

Tools and Measures

Perceived Stress Scale (PSS-10)

This scale was developed by Cohen et al. (1994) that is widely used to measure perceived stress. PSS-10 is a 10-item self-reported scale that asks the thoughts and feelings of respondents last month and a 5-point Likert scale is used for the rating (Lee, 2012). This scale originally had 14-item it was further shortened to a 10-item version. Various studies (Roberti et al., 2006; Lee, 2012) recommend PSS-10 as an effective tool to measure perceived stress. The scores are calculated by inverting the scores of the four positively mentioned items (items 4, 5, 7, and 8) and adding the totals. The maximum score obtained can be 40, with scores >27 is considered as high perceived stress. PSS-10 can be completed in less than 10 minutes.

Parental Stress Scale (PSS)

Berry and Jones (1995) developed PSS to assess feelings about their parental roles. It is an 18-item questionnaire representing positive factors and negative factors in parenting experiences that can be completed in under 10 minutes. The PSS is a 5-point Likert scale with self-reporting that assists parents in responding to their feelings and connections with their children. This scale was calculated by reversing the scores of items 1, 2, 5, 6, 7, 8, and 17 and adding the results. The possible scores range from 18 (low stress) to 90 (severe stress).

Attention Network Test (ANT)

Fan et al. (2002) developed this scale to measure three distinctive types of attention control networks namely executive control, orienting and alerting. It is converted computer based test by Posner (1992).It is now one of the most popular neuropsychological tests used to evaluate attention control (MacLeod et al., 2010). Various studies have found ANT efficient and reliable in independently measuring the three specialised networks of the attention process (Ishigami & Klein, 2010; Fan et al., 2002; Urbanek et al., 2009; Fuentes & Campoy, 2007).

The ANT test contains three types of target conditions namely normal, congruent and incongruent as in Figure 1. In the normal condition either an arrow would point to the left or right appears on the screen.

In some circumstances, the central arrow is flanked by two arrows on either side pointing in the same (congruent) or opposite (incongruent) direction. These targets are presented after one of the four cue conditions at random which helps in calculating the effectiveness of the various attention networks. The cues are no cue, central cue, double cue and spatial cue as represented in Figure 2. In some cases, the target appears directly without any cues (no cue) and in others, a brief cue stimulus before the target indicates the upcoming location of the arrow. The orienting signals appear above or below (spatial cue) the fixation point, indicating the exact location of the next object, whereas the non-orienting cue appears on the fixation point (centre cue) or both above and below it at the same time (double cue). Both the cues indicate to the participant that the target is going to appear but only orienting cues provide the exact location of the target. The test is displayed on a white background with all the elements appearing in black colour. The sequence of the ANT events is shown in Figure 3.

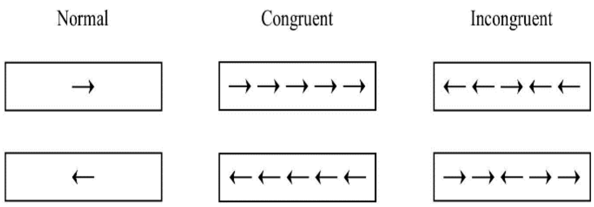

Figure 1. ANT Target Conditions

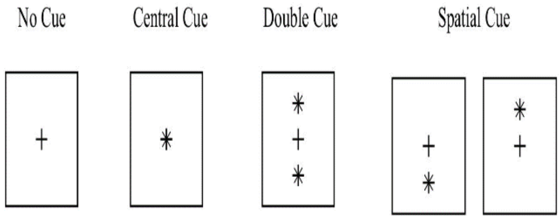

Figure 2. ANT Cue Conditions

First, a fixation point appears in the middle of the screen for 400 ms - 1600 ms, where the participants will be asked to focus. A cue is then presented for 100 ms and then again a fixation point which is for 400 ms. Finally, the target appears where the participants are supposed to identify the direction of the centre arrow by pressing the keys "E" for left and "I" for right as quickly and accurately as possible. If the participant did not respond the arrow will disappear in 1700 ms. The test consists of one practice block with 20 trials and six test blocks with 572 trials (Liu et al., 2020) which together will take approximately 30 minutes to complete. The reaction time and accuracy are recorded for each case, and each network's efficiency is assessed independently.

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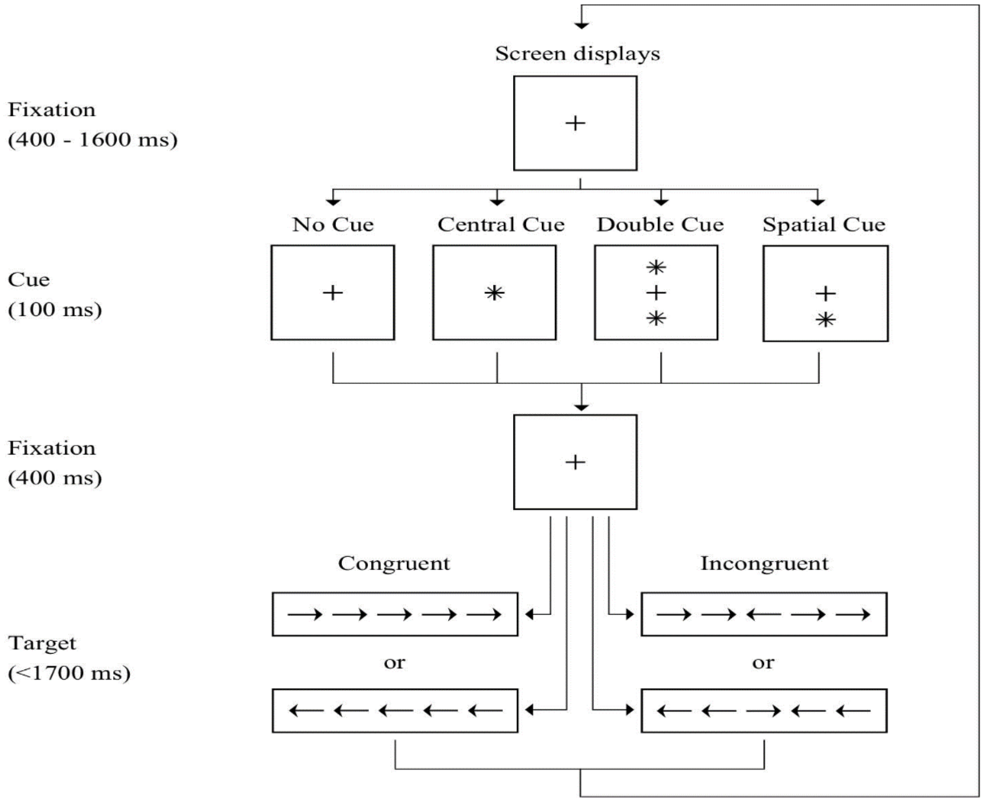

Figure 3. Sequence of Events in ANT

Procedure

This study was conducted without the use of any stimulants (such as smoking or drinking coffee). The researcher briefed about the research and received informed consent. The ethical committee (Institutional Research Board) of CHRIST (Deemed to be University) approved the research work. All the participants were individually screened by a psychiatrist for any existing mental conditions or disabilities. After the screening, the participants were given a perceived stress scale and a parental stress scale using the pen and paper method. After the completion of the tests, the scores of both tests were calculated by the researcher. Parents of children with NDD who received high scores on PSS-10 and PSS were recruited to the stressed group. Similarly, parents of children with TD who scored less on PSS-10 and PSS were recruited to the non-stressed group. The participants were then asked to perform ANT under the supervision of a researcher on a computer running a Windows operating system using the software Millisecond Inquisit version 6.

3. Results

All the subjects who participated in the study were mothers as we considered only the primary caregivers of the children for both the groups. Basic demographic information of the final sample and the results obtained from the self-report stress questionnaires, PSS and PSS-10 are shown in table 1. There was a distinguishable difference in stress levels in both the questionnaires among parents of children with NDD (stressed group) and parents of children with TD (non-stressed group). The stressed group reported more stress in taking care of the children which is also affecting their overall life. The stressed group (M= 22.2, SD= 6.1) scored higher in stress on PSS-10 when compared to the non-stress group (M= 11.1, SD= 3.9). A huge difference in stress levels can also be seen in the parental stress scale, where the stressed group (M= 44.1, SD= 9.6) scored higher than the non-stressed group (M= 20.1, SD= 2.1). Further analysis of the demographic data, such as the child's condition, years of exposure to stress, partner's caregiving level, participant's education level and the socio-economic status were not at this stage of the evaluation, though such information was collected from the participants.

Table 1. Results of self-reports and Demographic Information

Measures	Participants (n = 65)	
	Stressed group (n = 35; Mean± SD)	Non-stress group (n = 30; Mean ± SD)
Age range, years	25-44	26-45
PSS-10	22.2 (6.1)	11.1 (3.9)
Parental Stress Scale	44.1 (9.6)	20.1 (2.1)
Age, years	33.9 (5.4)	32.4 (6.3)

Accuracy and Reaction Time

Based on the descriptive analysis results the accuracy and reaction time of both stressed and non-stressed group given in the table 2. The stressed group had a shorter reaction time (M= 564.623, SD= 75.484) when compared to the non-stressed group (M= 588.874, SD= 101.575). However, the stressed group (M= 0.989, SD= 0.008) and the non-stressed group (M= 0.984, SD= 0.014) had similar overall accuracy. In the table 3 presented the two groups (Stressed and non-stressed) accuracy and reaction time with two conditions (congruent and incongruent) for four cue conditions (no cue, centre cue, double cue and spatial). The stressed group had a quicker reaction time in all the cue conditions for both the target condition when compared to the non-stressed group. The comparison between the stressed group and the non-stressed group for the different target and cue conditions is represented in figure 4 and figure 5.

Table 2. Descriptive Analysis of the Mean RT and Accuracy

	Subject	N	Mean	SD
Reaction Time	Stressed	35	564.623	75.484
	Non-stressed	30	588.874	101.575
Accuracy	Stressed	35	0.989	0.008
	Non-stressed	30	0.984	0.014

Table 3. Accuracy and Reaction Time Stressed and Non-stressed Parents in Cues and conditions

Target		No Cue	Centre Cue	Double Cue	Spatial Cue
Reaction Time (Mean ± SD)					
Stressed	Congruent	599 (81.7)	539 (72.3)	532 (81.8)	523 (71.4)
Incongruent		657 (84.6)	624 (93.5)	624 (87.3)	597 (83.2)
Non-stressed	Congruent	619 (116.3)	565 (113.1)	552 (102.3)	546 (103.1)
Incongruent		698 (122.4)	647 (112.9)	647 (104.4)	612 (107.4)
		Accuracy (Mean ± SD)			
Stressed	Congruent	0.996 (.015)	0.999 (.007)	0.995 (.013)	0.996 (.011)
	Incongruent	0.986 (.022)	0.984 (.027)	0.982 (.023)	0.981 (.032)
Non-stressed	Congruent	0.990 (.021)	0.983 (.030)	0.996 (.017)	0.996 (.017)
	Incongruent	0.980 (.030)	0.969 (.043)	0.975 (.037)	0.985 (.023)

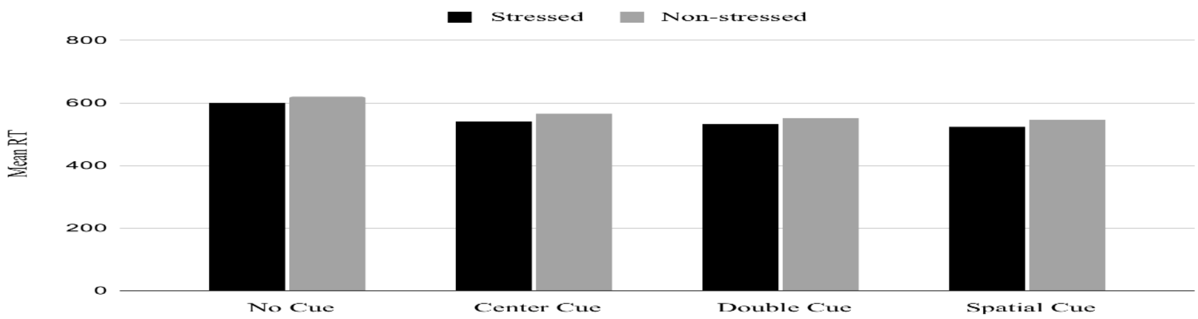

Figure 4. Mean Reaction Time of Congruent Trials for Stressed and Non-stressed Parents in Each Cue Conditions

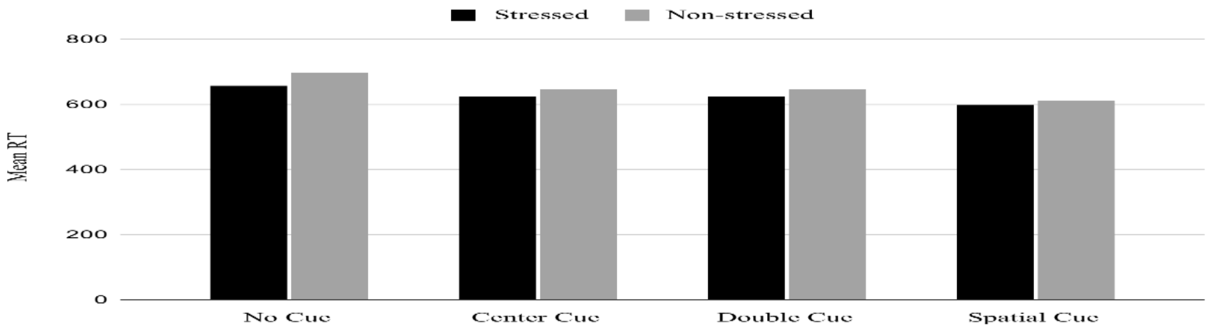

Figure 5. Mean Reaction Time of Incongruent Trials for Stressed and Non-stressed Parents in Each Cue Conditions

Attention Networks

In the table 4 descriptive statistics presented with normality, mean and standard deviation for the efficiency of the attention networks for the stressed and non-stressed group The stressed group scored lower scores for all three networks when compared to the non-stressed group. Further analysis of the data was done for each attention network of the stressed and non-stressed groups using the box plots. In the figure 6, the alerting network for the stressed group had a Mdn of 48.3 (IQR= 42.7) where as for the non-stressed group the Mdn was 57.1 (IQR= 44). In the figure 7, the orienting network for the stressed group had a Mdn of 20.7 (IQR= 37.2) and for the non-stressed group the Mdn was 25.7 (IQR= 37.5). For the executive control network, as represented in figure 8, the median were almost same with stressed group having a Mdn of 76.5 (IQR= 41.2) and the non-stressed group having a Mdn of 78.7 (IQR= 49.7).

Table 4. Descriptive Analysis of the Attention Networks

					Shapiro-Wilk	
	Subject	N	Mean	SD	W	P
AN	Stressed	35	49.8	31.0	0.968	0.390
	Non-stressed	30	58.4	35.5	0.982	0.874
ON	Stressed	35	21.4	33.7	0.932	0.033
	Non-stressed	30	27.0	26.4	0.958	0.279
EC	Stressed	35	77.2	32.9	0.970	0.446
	Non-stressed	30	80.3	29.5	0.967	0.472

Figure 6. Box Plots for Alerting Network for the Stressed and the Non-stressed groups

Figure 7. Box Plots for Orienting Network for the Stressed and the Non-stressed groups

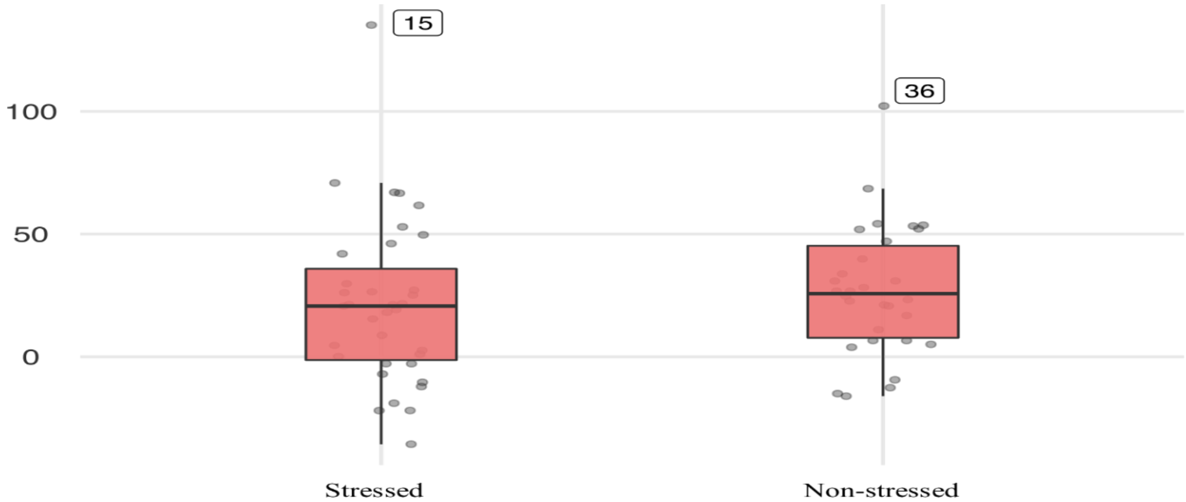

Figure 8. Box Plots for Executive Control Network for the Stressed and the Non-stressed groups

Based on the Shapiro-Wilk tests, the data was normally distributed for the alerting network for the stressed group ($W= .968$, $p > .39$) and the non-stressed group ($W= .982$, $p > .874$) are normally distributed. Similarly, the data for the orienting network for the stressed group ($W= .932$, $p > .033$) and the non-stressed group ($W= .958$, $p > .279$) are normally distributed. The data for the executive control network for the stressed group ($W= .97$, $p > .446$) and the non-stressed group ($W= .967$, $p > .472$) are also normally distributed. The Q-Q plots for each alerting network are also represented in figure 9 (alerting network), figure 10 (orienting network) and figure 11 (executive control network).

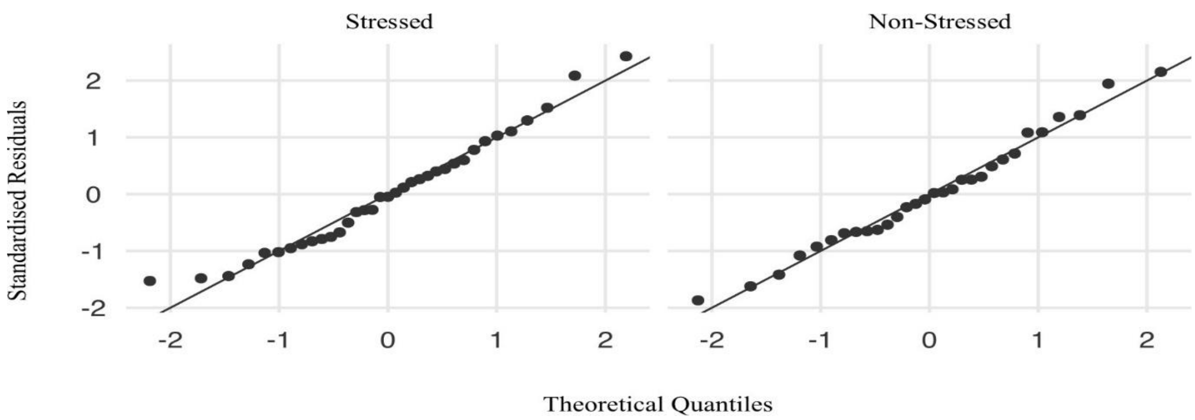

Figure 9. Q-Q Plots for Alerting Network for Stressed and Non-stressed Groups

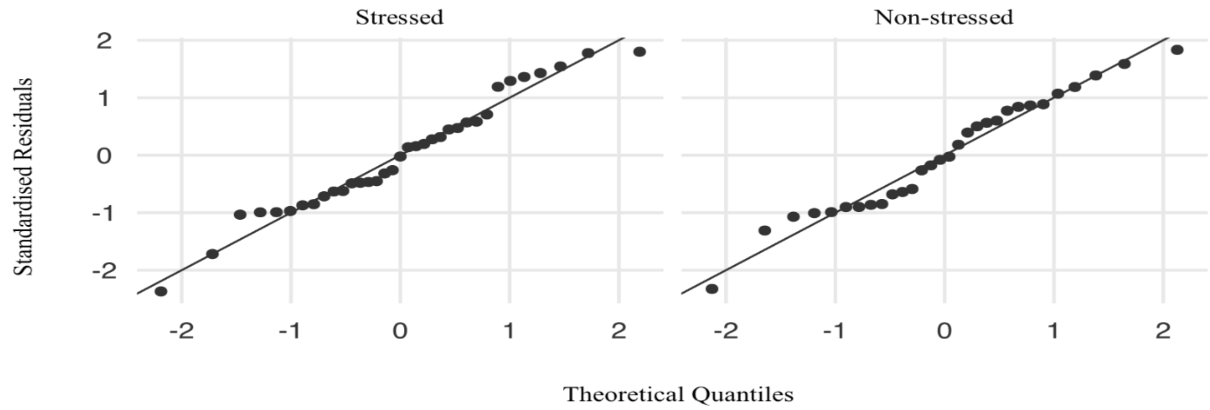

Figure 10. Q-Q Plots for Orienting Network for the Stressed and the Non-stressed group

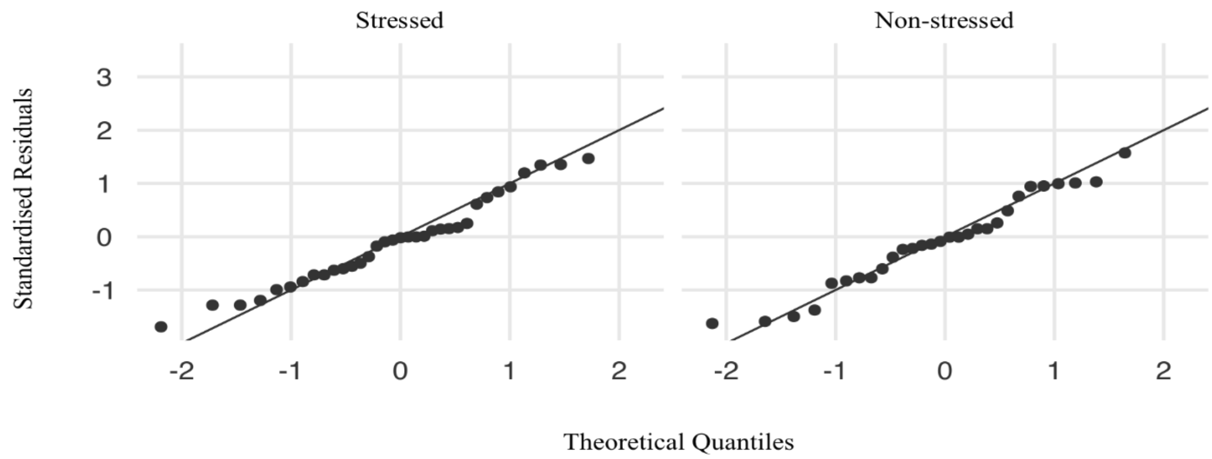

Figure 11. Q-Q Plots for Executive Control Network for the Stressed and the Non-stressed groups

An independent-samples t-test was performed to find the significance difference between stressed and non-stressed groups based on attention network, executive control network and orienting network. The results of the test are represented in table 5. No significant difference was found between stress group (M= 49.8, SD= 31.0) and non-stressed group (M= 58.4, SD= 35.5) for the alerting network; t(63)= -1.055, p= .295. Similarly, there was no significant difference found between the stress group (M= 21.4, SD= 33.7) and non-stressed group (M= 27.0, SD= 26.4) for the orienting network; t(63)= -.739, p= .463. No significant difference was also found between the stressed group (M= 77.2, SD= 32.9) and non-stressed group (M= 80.3, SD= 29.5) for the executive control network; t(63)= -.386, p= .701. These results suggest that there is no significant effect of stress on the efficiency of the various attention networks of the parents of children with NDD when compared to the parents of children with TD.

Table 5. Independent Samples T-Test of the Attention Networks

	Statistic		df	P		Effect Size
AN	Student's t	-1.055	63.0	0.295	Cohen's d	-0.2625
ON	Student's t	-0.739	63.0	0.463	Cohen's d	-0.1839
EC	Student's t	-0.386	63.0	0.701	Cohen's d	-0.0960

Further, a Pearson's correlation coefficient was calculated to find the relationship between the alerting, executive control and orienting attention networks for each group. The results of the correlation matrix for the stress group are represented in table 6 and for the non-stressed group in table 7.

Table 6. Correlation Matrix of the Attention Networks for the Stressed Group

		AN	ON	EC
AN	Pearson's r	-		
	p-value	-		
ON	Pearson's r	0.458**	-	
	p-value	0.006	-	
EC	Pearson's r	-0.371*	-0.202	-
	p-value	0.028	0.245	-

Note. * p < .05, ** p < .01, *** p < .001

Table 7. Correlation Matrix of the Attention Networks for Non-stressed Group

		AN	ON	EC
AN	Pearson's r	-		
	p-value	-		
ON	Pearson's r	0.196	-	
	p-value	0.299	-	
EC	Pearson's r	0.030	0.191	-
	p-value	0.875	0.313	-

Note. * p < .05, ** p < .01, *** p < .001

A strong positive correlation was found for the stressed group between the alerting network and the orienting network, r= .45, N= 35; and the relationship was found to be significant (p= .006). However, the alerting network and orienting network were not found to be significantly correlated for the non-stressed group; r= .19, p= .299. Similarly, a strong negative correlation was found between the alerting network and the executive control network for the stressed group, r= -.37, N=35; and the relationship was found to be significant (p= .028). No such correlation was found for the non-stressed group, r= .03, p= .875. A negative correlation was found between the orienting network and the executive control network for the stressed group, r= -.2, N= 35; but the relationship was not significant (p= .245). For the non-stressed group this relationship was positively correlated, r= .19, N= 30; however, the relationship was not significant (p= .313). These results suggest that the alerting network has associations with the orienting network and executive control network in the stressed group.

4. Discussion

This study is relatively an early effort to investigate the chronic psychological stress on executive control, alerting and orienting attention networks. An Attention Network Test was used to determine the efficiency of the attention networks in the parents of children with NDD (stressed group) and parents of children with TD (non-stressed group). We considered only the primary caregivers of the children for both the groups and hence all the subjects who participated in the study were mothers. PSS-10 and Parental Stress Scales were used to determine the stress levels of the parents. Higher stress was found in the parents of children with NDD on both the stress scales when compared to the non-stressed group. As Craig et al. (2016) pointed out in their study, a higher level of stress in these parents is due to the increased demands of caregiving for the children with NDD. This results in burnout due to the severe source of chronic stress (Pinquart, 2017).

As can be seen from the behavioural results, the stressed group has a slightly faster reaction time to the target stimuli for all the cue conditions compared to the non-stressed group. This was contrary to the findings of Liu et al. (2020). In his study, he conducted ANT on healthy undergraduate students undergoing a postgraduate entrance examination and found that the stressed group had a slower reaction time and accuracy compared to the controlled group. It is also to be noted that both the groups in the present study had comparable accuracy. So the faster reaction time of the mothers of children with NDD in the stressed group did not affect their accuracy. The faster reaction time observed in the mothers of the stressed group could be an outcome of their constant need for increased vigilance and alertness required to take care of a child with NDD. How naturalistic and prolonged psychological stressors like caregiving for children with NDD are affecting the brain networks for cognitive functions like attention are not very well explored yet.

In this study, a statistically significant difference could not be found between the stressed and non-stressed groups in any of the attention networks. Both the groups had almost comparable scores for the three attention networks. This suggests that there is no significant effect of stress on the efficiency of the various attention networks of the parents of children with NDD when compared to the parents of children with TD. Also, when comparing the strategies of attending to the stimuli, there wasn't any difference identified between the groups. Both the groups benefited from a double cue condition when compared to the no cue condition. This indicates that when an alert stimulus is given the participants were able to perform better at the task. No significant difference was found in the efficiency of the alerting network. When an orienting stimulus is given to the stressed group and non-stressed group, it was found that both the groups were performing better when compared to the centre cue. The efficiency of the orienting attention network is also similar for both groups. When comparing the congruent and incongruent trials, both the groups had a quicker reaction time for the congruent trials in all the cue conditions. This refers that both the groups had similar conflict resolution and executive control. The data for the stressed and non-stressed groups had larger SD, which may be because of the wider age group selected for the study. The severity of the child's condition and the duration of the care and the daily time spent with the child has a positive correlation to the intensity of the stress experienced (Romero-Martínez et al., 2018). In the present study, the stressed group participants were parents of children suffering from conditions of different levels of severity. Parents of children with ASD (n= 11), ADHD (n= 8), specific learning disabilities (n= 6) and specific language impairment (n= 10) with a duration of the condition ranging from 1-5 years were in the stressed group. This variation in the level of stress experienced and the length of the stressor could have altered the findings of this investigation. The data will be further analysed later with the above characteristics in mind.

The major findings of this study are the association found between the alerting and orienting networks and the alerting and executive control networks in the stressed group. A strong positive correlation was found between the alerting network and orienting network (p=.006) in the stressed group. Also, the alerting network and executive control network was found to be negatively correlated in the stressed group (p= .028). These two associations between the networks were not observed in the non-stressed group. This finding is consistent with the previous work of Callejas et al. (2005). The alerting system is automatic and does not have any cognitive control. It is a primitive attention network involved in the general level of arousal and alerting. The system involves projections from the locus coeruleus which is situated in the brainstem to the forebrain areas like the prefrontal and posterior parietal cortex (Kolb & Whishaw, 2009). Where as the orienting system is involved in prioritising sensory information by selecting a location or modality. It includes dorsal systems including the frontal eye field (FEF), interparietal sulcus (IPS) and temporal-parietal junction (TPJ) (Kolb & Whishaw, 2009). The executive control network is responsible for the starting, stopping and monitoring of a task, resolving conflicts and task switching. Frontal-parietal network and the cingulo-opercular network are two networks associated with the executive control network of attention. Repeated activation of the HPA axis has its effects on the primitive attention network involved in arousal and alerting. This activation of the alertness helps the orienting network to quickly orient to the salient stimulus (Callejas et al., 2005). This could be the explanation for the positive correlation observed between the alerting network and orienting network in the stressed group. Furthermore, the prolonged activation of the HPA axis has been shown to cause 'wear and tear' which inhibits the activities of PFC and mediates an automatic emotion-based response of the limbic system in the attention process (McCoy et al., 2015). Thus the activation of the alerting network could prevent the functioning of the executive control network function in the attention process (Callejas et al., 2005), resulting in more bottom-up approach. This explains the negative correlation found between the alerting network and the executive control network in the stressed group. No association was found between the orienting network and executive control network however in the stressed group.

5. Conclusion

The existing research is revealing the effects of acute and short-term stressors on various cognitive functions including attention. However, how naturalistic, chronic psychological stressors effects the attention not discussed much. This study the parental stress of caregiving for children with NDD are considered to explore its effects on the attention networks of the brain. ANT test was performed on parents of children with NDD and parents of children with TD and the scores for the executive control network, alerting network and orienting network was compared. Contrary to the literature, it was found that the stressed group had quicker reaction time when compared to the non-stress group, while the accuracy remained the same for both the groups. As the subjects of the study were the primary caregivers of the children with NDD, this quicker reaction time may be due to the outcome of their constant need for increased vigilance and alertness required to take care of a child with NDD. However, while comparing the attention networks no significant differences were found between both groups. Both the groups were able to utilise the alerting and orienting cues effectively and perform better than without helping cues. Also, the conflict resolution in performing the congruent and incongruent trials were also similar for both the groups. In summary, no differences were found between the stressed group and non-stressed group in the alerting, orienting and executive control networks of attention. According to the theory (Fan et al.; Posner, 1992; Posner & Dehaene, 1994) the three attention networks are distinctive and has no effect on each other. While this is true for the non-stressed group, the present study has found a significant correlation between the attention networks in the stressed group. The alerting and orienting network had a strong positive correlation and the alerting and executive control network had a strong negative correlation in the stressed group. Alerting being associated with the primitive brain regions responsible for the arousal, repeated activation of these network could have a significant impact on the attention control and strategies of attention in the stressed group. In summary, the activation of alerting network helps the orienting network to quickly orient to the salient stimulus, but inhibits the top-down control of the executive function in participating in the attention process. Future research should be focused on including the neuroimaging techniques to explore how these networks modulates another in chronically stressed people. This will also help to understand the long term effects of prolonged exposure to stress and the dysfunctions associated with neural networks of attention.

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