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The relation between contagious itch and autism spectrum disorder, and the role of tactile hypersensitivity.

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Abstract

Contagion is the tendency of certain behaviours to spread through a group of individuals. Examples of these behaviours are contagious behaviours such as yawning and scratching. Contagious behaviours have been linked to empathy and with that also mirror neurons, people that differ in their functionality in empathy might show reduced contagious behaviour. One population were this applies is for people with autism, research has shown contagious behaviours such as yawning to be reduced in these populations. Research on contagious itch within these populations however states the opposite, contagious itch is increased in these populations. Research has pointed to a possible explanation for this being tactile hypersensitivity among people with autism. The current study sought out to determine if scores on autism were related to contagious itch and if these scores were mediated by tactile hypersensitivity. Results found that scores of autism were positively related to tactile hypersensitivity. However, no relation was found between scores of autism and contagious itch, and no mediation effect for tactile hypersensitivity was found. We discuss that the role of empathy and the mirror neuron system is perhaps bigger than initially expected. More research on empathy and contagious itch within autistic populations is needed to better understand the relation between these two.

Introduction

Contagion refers to the tendency of a certain behaviour spreading through a group of individuals in a chain reaction. Behaviours that often trigger such reactions are behaviours that signify inner states of others (Hatfield, Caccioppo, & Rapson, 1994). Behaviours that elicit such responses for example are seen when infants in hospital nurseries cry when they hear other infants cry (Simner, 1971), and laughing tracks as heard in television comedies eliciting laughter in people watching (Bush, Barr, McHugo, & Lanzetta,1989). Certain contagious behaviours are also apparent when people observe others yawning or scratching themselves. For example, subjective feeling of itchiness can be evoked by watching others scratching themselves or by listening to a lecture on dermatologic conditions (Niemeier, & Gieler, 2000; Papoiu, Wang, Coghill, Chan, & Yosipovitch, 2011). Previous research on contagious itch and whether it differs in between individuals has focused on healthy individuals and Atopic Dermatitis (AD) Patients. Research by Papoiu and colleagues (2011) concluded that AD-patients showed a significantly higher increase in itch intensity and number of scratching movements when observing itch inducing stimuli than healthy individuals. Differences in stimuli have also been shown to elicit different responses in healthy individuals, images showing a "skin response" (scratching an insect bite) versus "skin contact" (insects crawling on skin) and "context only" (looking at insects) showed that the scratch response increased the most for the "skin response condition" (Lloyd, Hall, Hall, & McGlone 2013). Researchers also asked participants about how itchy the participants felt and how itchy they thought the person in the image they saw felt. Participants reported high itch sensations for themselves but also for the person they observed, this led to the suggestion that empathy might play an important role in the experience of contagious itch.

One candidate for explaining empathic processing is the mirror neuron system (Iacoboni, 2009). Mirror neurons were first discovered in monkeys and are a specific type of motor cell that fires both when the monkey was performing an action but also when observing that same action (Di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Iacoboni, 2009). Research also pointed to the possibility that mirror neurons could play a role in contagious itch (Ikoma, Steinhoff, Ständer, & Yosipovitch, 2006). Research on other contagious behaviours such as contagious yawning and the neural representation of this phenomenon tested whether the human mirror neuron system was activated by visually perceived yawning by use of FMRI. This research concluded that contagious yawing was based on a functional substrate of empathy and emphasized the connection between the human mirror system and

higher cognitive empathic functions (Haker, Kawohl, Herwig, & Rössler, 2013). Holle, Warne, Seth, Critchley, and Ward (2012) argue that a feeling-based system plays a crucial part in experiencing contagious itch, Holle and colleagues (2012) studied brain regions that were activated in individuals experiencing contagious itch. One of the regions that was activated during this phenomenon was the insula, a brain region that has been linked with affective components of bodily sensations, showed the most sustained activation during contagious itch (Holle at al., 2012). Current research seems to suggest that perhaps empathy and/or the mirror neuron system are involved in experiencing contagious itch. Then how does this affect individuals who function differently in these aspects?

Traditionally individuals with autism have been defined as having "persistent deficits in social communication and social interactions across multiple contexts" (DSM-V, American Psychiatric association, 2013). Autism is a developmental condition that is apparent at a young age and lasts through life (Ward, 2017) although people often come up with ways to hide or camouflage their behaviour later on in life. It has been stated that people with autism are lacking in empathy, on questionnaire measures of empathy this does seem somewhat true where people with autism score lower compared to "healthy" controls (Baron-Cohen & Wheelwright, 2004). This does not mean that empathy is non-existent in this group but that it is different in this group. However, these measures of empathy ask about high-level aspects of empathy that are likely involved with the mentalizing network, rather than being actually more feeling-based parts of empathy. Empathy can also be divided into multiple stages (Fletcher-Watson, Sue, Bird, 2020). For example, an individual must be able to detect that someone else is feeling something which requires the individual to be focused on the other. In the case of some autistic people, they might be less likely to detect someone's emotional cues as they are not orienting themselves towards the other. For example, people with autism make less eye contact and are focusing on other parts of the environment or body parts of the other (Kessels, Eling, Ponds, Spikman, & Zandvoort, 2018). The second step after noticing someone his emotional state is labelling what the other is feeling. Is the person crying because he/she is happy or sad? This may be a problem in some people with autism that have trouble identifying their own feelings, a phenomenon known as alexithymia (Hill, Berthoz, & Frith, 2004). People with autism might not differ as much in feelings of empathy but as stated before they might encounter difficulties in detecting or expressing feelings or behaviours of others.

The broken mirror theory of autism argues that social difficulties people with autism encounter are a consequence of mirror neuron system dysfunction (Iacoboni & Dapretto,

2006; Oberman & Ramachandran, 2007; Rizolatti & Fabbri-Destro, 2010). Structural MRI research done by Hadjikani, Joseph, Snyder and Tager-Flusberg (2006) examined anatomical differences between matched controls and people with autism. Findings from this study showed that the autistic individuals had a reduced amount of grey matter in regions that were linked to the human mirror system, these regions specifically being the "Inferior frontal gyrus pars opercularis", "Inferior parietal lobule" and "Superior temporal sulcus". Furthermore, reduced grey matter in these brain areas correlated with severity of autism symptoms. An EEG study by Oberman and colleagues (2005) recorded MU waves in autistic children. Mu waves are a synchronized pattern of electrical activity and occur at a particular frequency of 8-13hz and are greatest when someone is doing nothing (Ward, 2017). When someone performs an action there is a decrease in the amount of mu waves, this is what is called mu suppression. This mu suppression also occurs when someone observes another person performing an action, because of this occurrence it has been considered to be a measure of mirror neuron activity by some (Pineda, 2005). Oberman and colleagues (2005) found that autistic children did not show as much mu suppression as controls did when observing actions but did show as much mu suppression in the control condition where they performed an action.

As noted earlier, empathy and the mirror neuron system were suggested to play a role in contagious behaviour such as contagious itch. While empathy could in some cases be affected in autistic individuals as evidenced by questionnaires (Baron-Cohen & Wheelwright 2004) or failure to attend to others or trouble with interpreting feelings (Kessels et al., 2018; Hill et al., 2004) research also showed that people with autism have a "normal" brain response to other's pain expressions (Hadjikani et al., 2014). Research on the mirror neuron system also seems to point to a deficit in the mirror neuron system of autistic individuals. It is important however to not see the mirror neuron system and empathy as two different things, as the mirror neuron system seems to be broadly involved with empathy (Baird, Scheffer, & Wilson, 2011). Hadjikani and colleagues (2006) found anatomical differences between autistic individuals and matched controls relating to the mirror neuron system and Oberman and colleagues (2005) found that autistic children showed less mu suppression when observing an action. Based on theories on empathy and mirror neuron systems one could expect autistic individuals to show less contagious behaviour compared to "healthy" controls.

Research on contagious yawning seems to support this idea, Senju and colleagues (2007) found that children with autism elicited less yawning compared to an age matched group. Other research by Helt, Eigsti, Snyder and Fein (2010) supports this finding and added

to the subject by also comparing individuals with Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS) which is a milder variant of autism which existed in the DSM-IV. Children with PDD-NOS were more susceptible to contagious yawning compared to children diagnosed with autism spectrum disorder. These findings however are contested, Giganti and Esposito Ziello (2009) argue that the deficits found in experiencing contagious yawning in autistic children could be due to difficulties in establishing reciprocal gaze behaviour with others. Research by Senju and colleagues (2009) again looked at contagious yawning in autistic children but this time participants received the instruction to fixate on the eyes of the face stimuli. Autistic children and age matched children did not differ in their yawning behaviour. This research suggests that contagious yawning can occur in autistic children if they are instructed to fixate on the eyes of the face stimuli.

But how does this relate to contagious itch? As suggested by research one might expect deficits in empathy and the mirror neuron system and therefore a reduced expression of contagious itch. However, research on contagious yawning shows that attending to the eyes helped individuals in experiencing contagious yawning. In the case of contagious itch there does not have to a fixation on the eyes, someone could for example be scratching their arm. Perhaps in this case autistic individuals would show no difference compared to "healthy" controls. Research by Schineller (2018) showed that children with autism demonstrated an increased contagious itch when compared to age matched controls. Further research by Helt and colleagues (2020) also found that children with autism showed an increased susceptibility to contagious itching compared to age matched controls. They also found that contagious itching showed no relationship to empathy and was positively correlated with autism symptom severity among autistic children.

One important subject discussed by Schineller (2018) is the topic of sensory hypersensitivity. Schineller argues that perhaps the increase of contagious itch among autistic children is caused by an increased tactile hypersensitivity, or sensory hypersensitivity in this population (Güçlü, Tanidir,Mukaddes, & Ünal, 2007; Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009). Further research on tactile hypersensitivity in this population also demonstrates lower tactile perceptual thresholds in a group with Asperger and perceptions of tactile stimuli being experienced as being more tickly and intense (Blakemore et al., 2006). Children with autism also show a higher impact of uncomfortable tactile stimuli than their typically developing counterparts, such as being more bothered by itching clothing tags (Baron-Cohen et al., 2009). One possibility is that autistic children find it easier to learn itching behaviours because they are already familiar with feeling itchy and express this

feeling naturally (Schineller, 2018). A similar finding has been shown by Schut and colleagues (2015) doing research on individuals with atopic dermatitis and how they are affected by contagious itch. Schut and colleagues (2015) in this study concluded that these individuals are more likely to experience contagious itch. Perceptions of touch are influenced by a person's sensitivity to tactile stimuli, in the case of individuals with autism the threshold for perceptions of touch seems to be lower and the experience is more intense (Blakemore et al., 2006) and was also shown in general between autism and tactile hypersensitivity (Güçlü, Tanidir, Mukaddes, & Ünal, 2007). Perhaps this sensitivity is indeed the cause of heightened contagious itch in autistic individuals.

To add to the learning aspect of itch in autistic individuals, a review article (Schut, Grossman, Gieler, Kupler, & Yosipovitch, 2015) discussed one of the possible reasons for contagious itch being conditioning. Research discussed in this review article was by Jordan and Whitlock (1972, 1974) who were able to show that a scratch response could be conditioned in atopic dermatitis patients and healthy controls. One interesting finding in these studies was that chronic itch patients reacted with a higher conditioned scratch response compared to control groups. Atopic dermatitis patients seem to be able to learn itching behaviours easier compared to controls because they are already familiar with itch. This relates back to the suggestion by Schineller (2018) that contagious itch might be explained by tactile hypersensitivity and children with autism already being familiar with itch.

Previous research on contagious itch and autism has concluded that it is heightened in this population (Schineller, 2018; Helt et al., 2020), not much research has been done on contagious itch and autism. However, Schineller highlighted a very important aspect on what could explain the relation between autism and contagious itch, the aspect of it being related to sensory hypersensitivity and specifically tactile hypersensitivity. Furthermore, research by Helt and colleagues (2010) looked at individuals with milder variants of autism such as PDDNOS and found that individuals PDDNOS were more susceptible to yawning than individuals with autism. This finding suggests that autism severity might be related to susceptibility of contagious behaviours, in the current study we will be looking at scores of autism to explore this idea. Because of these suggestions the current research will be focusing on exploring this relationship, the main question presented in this study is "What is the relation between contagious itch and scores on autism, and is this relation mediated through tactile hypersensitivity". The expectation for this research question is "There is a positive relation between scores of autism and contagious itch, and this relation is mediated through tactile hypersensitivity".

Methods

Participants. The participants included 82 initial respondents, after correcting for missing data this number got reduced to 50 (N = 50. Of these participants 34% were male (N = 17) and 66% female (N = 33). All the participants were over 18 years old and ranged from 18 to 69 years old (M = 23.84, SD = 9.427). Participants have been collected through the use of Sona Systems and social circles from the researchers. Sona Systems is a platform which students at Utrecht University use to participate and setup their own studies. Personal information was collected for participants, such as age, gender, and highest education achievement. For this current study we were interested in adults and therefore only selected participants over the age of 18. Participants were informed about the study beforehand and have read and agreed through a written consent.

Material. To measure the contagious itch 2 videos were created which were shown separately during the experiment (Lloyd et al., 2013; Rifi, n.d.). These videos were based on previous research by Holle and colleagues (2012). The videos were filmed through use of an iPhone 5. The first video which contains the itch stimulus shows a woman scratching her left arm with her right hand, we used a neutral black shirt and did not show the face of the person. The second video is the same movement and same frame except that the hand does not perform a scratching movement but is tapping the left arm. The face of the person was not visible to prevent facial expression having an influence on the participant. The first video with the scratching is the experimental condition, the video with the tapping is the control condition. Both videos were shown for 20 seconds and each one a total of 10 times to the participant. After each video is shown the participant is asked to rate his/her perceived itch at that moment. Before the first video is shown participants are also asked their perceived itch to determine a baseline. The two questions asked to evaluate perceived itch were “How much itch do you experience at this moment?” and “how much itch do you think the other person experiences?”. Both these questions were scored using a VAS scale which ranged from 0 to 100 with 0 being “no itch” and 100 being the “worst imaginable itch” (Crichton & Nurs, 2001).

Figure 1 showing the experimental condition

Figure 2 showing the control condition.

To measure scores on autism the Autism Spectrum Quotient (AQ) was used. The AQ is a questionnaire about behaviour and personality and screens if these measures accord with symptoms of Autism spectrum. The questionnaire consists of 50 statements relating to behaviour and personality. Results from Woodbury-Smith, Robinson, Wheelwright, and Baron-Cohen (2005) concluded that the AQ has a good discriminatory validity and screening capabilities for Autism spectrum. The current study was performed on a Dutch population and usage was made of the Dutch translation, this Dutch translation was tested by Hoekstra, Bartels, Cath, and Boomsma (2008) which found that the internal consistency, and test-retest reliability were satisfactory. Also, high scores on the AQ were specific to individuals with Autism spectrum disorder. The conclusion was that the Dutch translation of the AQ was a reliable instrument to assess Autism spectrum disorder.

To measure tactile hypersensitivity the GSQ was used, The GSQ is a 42-item sensory sensitivity self-report questionnaire that receives more and more international scientific attention (Horder et al., 2014; Ward et al., 2017). The items cover seven modalities visual, auditory, gustatory, olfactory, tactile, vestibular, and proprioception. Each modality is represented by six items, three hypo-, and three hyper-sensitivity–related items. The items refer to one's behaviour to certain sensory stimuli or certain sensory preferences. Each item can be scored on a 5-point scale (never, rarely, sometimes, often, and always), with scores ranging from 0 to 4 and a possible total score of 168. The GSQ provides a total score, a score for each modality, a hypo- and hyper-responsiveness score per modality, as well as a total

hypo- and hyper-responsiveness. The GSQ has a Dutch translation which has been tested by Kuiper, Verhoeven, and Geurts (2018). Kuiper and colleagues (2018) concluded that the Dutch version was just as valid and reliable as the original and is usable for clinical practice and research purposes.

Furthermore, participants also answered the questionnaire “Prikkelgevoeligheid vragenlijst”, the “Prikkelgevoeligheid vragenlijst” is a questionnaire designed to be used for chronic patients with brain damage. The questionnaire consists of 60 questions divided into six modalities, the stimuli Taste, Smell, Movement, Visual, Touch, activity and auditory are part of this questionnaire. This questionnaire was not used in the current study but served to collect data for a different study.

Procedure. To present the different tests to the participants a questionnaire study was setup using Qualtrics. The questionnaires and stimulus material were presented in a standard order and in the Dutch language. Participants took part in the study on their own time making use of a computer or smartphone. Before the start of the experiment participants were asked to read and agree on a written consent. After agreeing on the consent participants were asked their age, gender, and highest achieved education. Only participants above 18 years old were allowed to partake in this study, if a participant answered that they were below 18 years old the study ended. Participation was voluntary, the participant was made aware that at any point in time they could stop their participation to the study without giving any reason for this.

The experiment started with a welcome screen which told the participant they were about to fill in four questionnaires, which were to be used to assess tactile sensitivity and scores on autism. This also listed how long the experiment would approximately take, this was between 30 to 45 minutes. Participants were informed that after every questionnaire a pause screen would be shown, this pause screen informed the participant which questionnaire was up next, how many questions it contained and how long it would take.

To prevent any possible priming, the experiment started with the questions on perceived itch and the associated videos. Before starting the participants were presented with a welcome screen telling them that they were about to see short videos after which they had to answer questions. Participants were first shown the questions with no videos to determine a baseline, after this baseline determination participants were shown each condition 10 times. After each video they were asked their perceived itch. Two questions were used “How much itch do you experience at this moment?” and “how much itch do you think the other person experiences?”. These questions were rated on a VAS scale. After this section participants were shown the AQ questionnaire, again first showing a pause screen with information. After

the AQ the “prikkelgevoeligheid vragenlijst” was presented which was followed by the GSQ.

After filling out the questionnaires, participants were presented with a short debriefing, in the debriefing participants were thanked for their participation and if they had complaints or questions, they could send them to one of the listed e-mail addresses. Furthermore, participants got explained the purpose of the research: the relation between contagious itch and autism and if this was mediated by tactile hypersensitivity. Participants were told contagious was not named in the research to prevent possible priming.

Data analysis

Data analysis was performed using IBM SPSS statistics 24. Usage was made of a ‘linear bivariate regression: one group size of slopes. Analysis started with checking the data file for missing values and removing participants with these missing values. The data was checked for outliers and Multicollinearity, assumptions were met. Statistical significance for testing was $p < 0.05$. Contagious itch scores were averaged for every participant and AQ and GSQ scores were calculated. In mediation analysis total scores of AQ will be used as the independent variable with average scores of contagious itch as the dependent variable, scores on the GSQ will be used as the mediator in this analysis. This analysis will determine if scores on the AQ are related to scores on the GSQ and if these can predict contagious itch.

Results

Table 1 shows the ranges and average scores of the participants on the AQ, GSQ, and contagious itch. For the AQ (Hoekstra et al., 2008) is a cut-off score of 32 determined, which is a good indicator for autism. For the GSQ a cut-off score of 56.55 is used, 95% of typical developed people do not score higher than this (Kuiper et al., 2018). The relation between scores of autism and tactile hypersensitivity is statistically significant, $b = 0.78$, 95% CI [.06, 1.50], $t = 2.18$, $p = 0.034$. This means that for a higher score on autism a higher score of tactile hypersensitivity is present. However, this is not the case for the relation between tactile hypersensitivity and contagious itch, $b = 0.20$, 95% CI [-0.03, 0.43], t = 1.74, p = 0.089. This means that a higher score on tactile hypersensitivity has no relation with a higher score on contagious itch. Also, no direct effect was found, $b = -0.23$, $p = 0.436$, and also no indirect effect, $b = 0.15$, [-0.09, 0,57]. This means that there is no significant relation between scores of autism and contagious itch and that this relation is also not mediated by tactile hypersensitivity. Analyses were performed through use of bootstrapping. The indirect effect was calculated for every 5000 bootstrap samples with a reliability interval of 95%.

Table 1

The range and average scores on the AQ, GSQ, and contagious itch

Task	Range		*M*
	min	max	
AQ	6	34	16.22
GSQ	9	91	35.86
Contagious itch	.63	77.39	18.28

Discussion

We aimed to elucidate the research on the relation between autistic traits, contagious itch and tactile hypersensitivity. Results from our study confirm a positive relation between scores of autism and tactile hypersensitivity. However, results indicate that there is no relation between scores of autism traits and contagious itch, and with that also no mediation effect through tactile hypersensitivity.

The results on autism and tactile hypersensitivity are consistent with previous research suggesting that autism scores correlate with scores on tactile hypersensitivity (Blakemore et al., 2006; Cascio et al., 2008). Previous research tested tactile hypersensitivity in autistic individuals through experimental means (Blakemore et al., 2006; Cascio et al., 2008), the current study shows that it is also possible to find this relation through usage of the GSQ questionnaire. This finding strengthens the position for the GSQ as a screening tool and makes it a valid tool to screen for tactile hypersensitivity in future research when scores on autism are compared.

Contrary to research by Schineller (2018) and Helt and colleagues (2020), our results do not show an increased contagious itch in this population. One possible explanation for our differing finding might be that empathy is more involved in contagious itch than was originally expected. Other contagious behaviours such as yawning have been linked to empathy, (Platek, Criton, Myers, & Gallup, 2003) contagious yawning has been shown in studies to be less present in groups of autistic children (Helt el al., 2010; Senju et al., 2007). Evidence for the role of empathy in contagious itch has also been found. Research looked at the sensation of itch and scratch responses (Lloyd et al., 2013). Participants viewed static images that were itch related or neutral. These were further divided into groups were there was ‘skin contact’ (ants crawling on a hand), ‘skin response’ (scratching an insect bite) or ‘context only’ (viewing birds flying). One important result was that participants reported high

itch sensations for both themselves as well as the imagined subjects in the pictures, the researchers pointed out that this could be evidence for the role of empathy in itch perceptions (Lloyd et al., 2013.

Closely related to empathy, mirror neurons have also been theorized to be involved in the experience of contagious itch (Ikoma et al., 2006). Furthermore, research by Haker and colleagues (2013) concluded that contagious yawning was based on a functional substrate of empathy and emphasized the connection between the human mirror system and higher cognitive empathic functions. Previous research stated that the mirror neuron system is not completely impaired in autistic individuals (Schineller, 2018), results suggest that perhaps there exists a variation in mirror neuron density relating to different behaviours. Autistic individuals might be more experienced with itch behaviours compared to other contagious behaviours as discussed by Schineller (2018). Children with autism show higher impact of uncomfortable stimuli than typically developing age matched counterparts (Baron-Cohen et al., 2009). It is possible that children experience all the contagious behaviours discussed equally but find it easier to learn itch behaviours because they are familiar with these and experience them naturally (Baron-Cohen er al.,2009; Schut et al., 2015; Schineller 2018). Thus, the discrepancy in contagiousness is related to both associative learning and mirror neuron functionallity relating to these behaviours. It is however clear that autistic individuals experience less associative learning of behaviours compared to their age matched counterparts (Preissler, 2008; Sapey-Triomphe, Sonié, Hénaff, Mattout, Schmitz, 2018), it does make sense that mirror neuron density would be reduced in this population, as is also evidenced in EEG studies (Oberman et al., 2005). This EEG study recorded mu waves in autistic children. Mu waves are synchronized patterns of electricity at a particular frequency of 8-13hz and are greatest when someone is doing nothing (Ward, 2017). When someone performs an action or observes another person performing an action these waves are reduced, this is called mu suppression. This mu suppression has been considered to be a measure of mirror neuron activity (Pineda, 2005). This EEG study found that autistic children showed less mu suppression compared to controls when observing action (Oberman et al., 2005).

It is also possible that mirror neuron mechanisms related to certain behaviours may be less impaired in autism, other mirror neuron mechanisms may be intact or even enhanced (Schineller, 2018). Schineller suggests that the mirror neuron system is the underlying system causing contagious itch to be heightened in autistic individuals compared to other contagious behaviours. The current study did not account for empathy or mirror neurons and strictly focused on scores of autism, tactile hypersensitivity, and contagious itch. The theory on

empathy and mirror neurons could explain why the current study did not find the expected relation between scores on autism and contagious itch and the mediation through tactile hypersensitivity.

Another point of interest could be the severity of autism, research by Helt and colleagues (2010) on contagious yawning found that children with autism showed less contagious yawning. However, they also tested contagious yawning in children with PDDNOS, a milder variant of autism and found that they showed more susceptibility to yawning. If contagious itch really is positively related to autism than one might expect individuals with milder variants such as PDDNOS to show less of a positive relation or maybe not differ at all from controls. Our study made use of the AQ test, which is a screening test for autism, high scores on this test indicate a possibility of an individual having autism. Our sample size was rather small, initially we had 82 responses but had to exclude participants because of missing answers leaving us with 50 responses. Of these responses most scored within the normal range with 9 people scoring above average or higher, possibly our sample might not be representative of the group we wished to test. If the previous idea about milder autism variants showing less contagious itch was true, we could expect our sample to also show less or no relation explaining our finding.

Another limitation of the current study is that we made use of an online study relying on self-report data. A paper by Lelkes, Krosnick, Marx, Judd, and Park (2012) looked at the accuracy of self-reports and found that when participants were completely anonymous measurement accuracy was decreased compared to when participants were identifiable. Besides the inaccuracy other studies on contagious yawning and itch have made usage of observations through videotaping of the participants and noted how often they exhibited yawning or scratching during the experiment (Helt et al., 2010; Helt et al., 2020; Schineller, 2018). Due to current limitations, we were not able to perform our research in the lab and had to resort to self-report scores on experienced itch.

An important limitation relating to our sampling is the fact that the majority of our sample was female with 33 participants compared to males with 17 participants. Autism has been seen as mostly a male issue, with some theories such as the “Extreme Male Brain theory” stating that autism can be seen as an extreme of the typical male profile (Baron-Cohen, 2010). Compared to males, females have a much higher chance of not being diagnosed with autism, their difficulties are often mislabelled or missed in its’ entirety (Lai, Lombardo, Auyeung, Chakrabarti, & Baron-Cohen 2015). One explanation for this is that there exists a female phenotype of autism that differs from male based conceptualisations of

autism (Bargiela, Steward, & Mandy, 2016; Mandy & Lai, 2016). Females show higher social motivation and greater capacity for friendships than males (Head et al. 2014; Sedgewick et al. 2015), furthermore females are less likely to have externalizing behaviours and are more vulnerable to internalising problems (Mandy et al., 2012). One important characteristic of females with autism is masking of autism symptoms, as reported by Bargiela and colleagues (2016) females deployed behavioural strategies to try and fit in with others. Most questionnaires on autism do not consider these gender differences and masking behaviours that people can use, this is also true for the AQ as used in our study (Rynkewicz et al., 2016). This could have caused scores on autism by females to be lower in our current study than they might have been in reality.

For the future, further research on the relation between empathy and the mirror neuron system in relation to contagious itch could shed more light on if these are more related than initially thought. Multiple limitations have been named, of which two important ones are listed. Firstly, important for future studies is measuring unconscious behaviour, such as recording participants' scratch behaviour to determine if there is a difference between self-reported data and observed behaviour. And lastly to put more emphasis on gender differences in autism, either through use of a diagnosed population or usage of a questionnaire that considers these differences.

Concluding, the current study found a positive relation between scores on autism and tactile hypersensitivity. However, results suggest that there is no positive relation between scores of autism and contagious itch and no mediation through tactile hypersensitivity. Current study findings could be explained through the influence of empathy and the mirror neuron system on contagious itch. Future research on empathy and its' relation with contagious itch in autistic populations is needed to further the knowledge in contagious behaviours among autistic individuals.

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