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The effects of 'preferedness of task' on stress, emotion, and behaviour responses to forced activity transitions in boys with ASD

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ABSTRACT

Background: Many children with Autism Spectrum Disorder (ASD) exhibit distress when asked to transition from one task to another. This study aimed to determine if physiological stress during transition was due to ASD-related rigidity or to their preference for some tasks over others.
Method: The effects of change of task alone versus a change in task 'preferedness' when undergoing forced activity transition were investigated in 29 boys with Autism Spectrum Disorder.
Results: Total sample data indicated a significant increase in heart rate (HR) during transition from a preferred to a non-preferred task, but not during transition from one preferred task to another preferred task, or from a non-preferred task to a preferred task. These data are suggestive of an effect due to the 'preferedness' of the task rather than just the change in task alone. Two subgroups of participants emerged, one which followed the 'expected' HR responsivity model to stress, and one which failed to follow that model.
Conclusion: Transition-related distress may be confounded by preferredness of task when understanding transition stress in boys with ASD.

1. Introduction

1.1. Preference for sameness and transitions in ASD

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder diagnosed by difficulties in Social Communication and in the exhibition of Restricted and Repetitive Behaviour (RRB) (APA, 2013). The 'restricted' behaviour aspect of the latter diagnostic criterion for ASD is manifest in a narrowness of focus, inflexibility of interests and activities, plus an insistence that the environment remains the same (Leekam et al., 2011). The latter is sometimes referred to as a 'preference for sameness' which may be so intense as to be described as an 'insistence' on sameness (Szatmari et al., 2006), and is evident when these children are required to change from one task to another (referred to as a 'transition'), a process that is often accompanied by stress, agitation, and challenging behaviour (APA, 2013). As well as being a key diagnostic indicator of ASD, this resistance to change tasks has been shown to negatively impinge upon academic and social interaction success in children with ASD (Dunlap et al., 1983; Hsiao et al., 2013; Saito et al., 2017; Wolery et al., 1985), principally because of their difficulty in making the required transitions to different learning tasks that occur within the classroom.

That is, when forced by adult/carer demands to make a task transition, some children with ASD may find this stressful, and may exhibit challenging behaviour (Lequia et al., 2015; Prior and Macmillan, 1973; Sterling-Turner and Jordan, 2007). Although this resistance to task transitions can also be observed in non-ASD children as an adaptive response to uncertainty, stress and anxiety that arise during periods of transition (Evans et al., 1997; Gotham et al., 2013), it is gradually modified in the typically-developing child as more appropriate coping behaviours are learnt (Evans et al., 1999); this modification does not occur in some children with ASD (MacDonald et al., 2007). Hence, resistance to task transition remains a potential key link to the challenging behaviour exhibited by many children and adolescents with ASD, particularly in the classroom where such transitions are regularly required.

1.2. Change vs preference

There are at least two possible conditions under which familiar task transitions may be stressful for children with ASD (Evans et al., 1999). That is, when they are participating in the range of learning activities presented to them in classrooms, children are required to stop doing one activity and start another on multiple occasions. Some children with ASD may find this transition from one activity to another activity distressing simply due to the change in tasks *per se* (i.e., due to their

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Table 1
Means (SD, ranges) for age, WASI-II Full Scale IQ, CASI-GAD score, and Heart Rate (bpm) during each experimental phase.

Variable	Age (yr)	WASI-II FS IQ	CASI-GAD	HR (bpm)				
				Adaptation	Preferred 1	Preferred 2	Non-preferred	Preferred 2
Mean	14.4	94.7	7.4	82.3	81.3	79.4	82.4	77.6
SD	2.7	10.6	4.3	14.5	13.9	13.7	13.5	12.0
Range	9–18	74–124	1–17	61–113	61–114	57–116	63–120	59–113
5% trimmed mean	14.5	94.4	7.3	81.7	80.7	78.7	81.5	76.9

ASD-related resistance to change), potentially triggering challenging behaviour when they are forced to change tasks, despite those transitions being familiar to the child and announced in advance by their teachers. Alternately, challenging behaviour that occurs when tasks are changed may be associated with the ASD child/adolescent being forced to stop doing an activity that they prefer, and instead commence an activity that they do not prefer. In this case, the challenging behaviour might not be completely related to ASD but instead be at least partially associated with their desire to continue undertaking tasks they prefer rather than tasks they do not prefer. This distinction regarding the possible basis for challenging behaviour when forced to change tasks is important because it can potentially explain whether any observed challenging behaviour that arises when tasks are changed is ASD-driven or just preference-driven. If the latter is the case for a particular child-task-behaviour association, then it might be better conceptualised as not solely an outcome of ASD.

One method of determining if stress arising from a task transition is due to ASD-related resistance to change, or an outcome of preferedness of task, is to measure their physiological stress responses to both types of task-change. This might be examined within an experimental setting where children are required to make three kinds of task changes about which they have been forewarned: (1): from a 'preferred' task to another 'preferred' task, (2) from a 'preferred' task to a 'non-preferred' task, and (3) from a 'non-preferred' task to a 'preferred' task. Such a range of task changes could enable comparison of the physiological stress responses of ASD children when they experience task change *per se*, versus when they experience task changes related to 'preferredness' of the task.

1.3. Task change and physiological arousal

Although most previous reports have referred to parental evaluations of their child's stress and anxiety regarding task transitions (e.g., Hsiao et al., 2013; Saito et al., 2017), the key indicator of physiological stress arousal that is also a major component of anxiety is the response of the autonomic nervous system (ANS) (Hall, 2016). The ANS acts through two subsidiary systems: the sympathetic (SNS) and the parasympathetic (PNS) nervous systems, with the SNS being the primary indicator of response to stress. SNS activity may be measured by several parameters, including skin temperature, skin conductance, and heart rate (HR), but HR represents the most informative of these three indices in an experimental setting because it also responds quite quickly to PNS activity (i.e., when the participant relaxes). Because residual moisture on the skin, or blood flow through tissues, can confound skin conductance or temperature data by appearing to represent elevated SNS activity after it has actually passed, HR remains one of the most valuable indicators of SNS and PNS activity (Stern et al., 1980).

1.4. Aims and methodological issues

Therefore, the current study explored the effect of task change combined with preferredness using HR as an index of physiological arousal. Using an $ABBB_1B$ design (where A = Adaptation, B = preferred task and B_1 = non-preferred task), young people with ASD were instructed to change tasks on direction from an unfamiliar adult. As well as HR data, participants' rates of task completion and adherence to the tasks were measured, and their self-evaluation of their emotional state and intensity during experimental phases was also collected and compared with the same data collected from their parents' observations of their child during the experiment. This protocol is described in detail in Methods but was designed to allow manipulation of kind of task (preferred *vs* non-preferred) while recording each participant's self-reported and parent-reported emotional state as well as their HR changes. Because task-preference may have wide individual variability in terms of the actual tasks children might prefer/not prefer, it was decided not to use a standardised stressor, but to enquire from participants' parents about tasks which their child preferred and tasks which they did not prefer, and to choose those non-preferred tasks which parents considered elicited the strongest negative emotional responses from their child, and those preferred tasks which parents considered that their child enjoyed the most. While it was considered to collect this information from the children themselves, the possibility that they would not wish to identify a non-preferred task, or would (justifiably) obscure the extent of their non-preferredness for that task, led to the identification of these tasks by an adult who was very familiar with her child' preferences.

2. Method

2.1. Participants

Participants were 29 boys with ASD who were recruited from parent support groups and other service organisations in Queensland, Australia, plus their mothers (27) or fathers (2). Age and IQ data for the ASD participants are shown in Table 1. All these boys had received a diagnosis of ASD via the second edition of the Autism Diagnostic Observation Schedule (ADOS-2) (Lord et al., 2012) by a research-reliable ADOS-2 trained assistant during recruitment; they all also had a Full Scale IQ above 70 on the Wechsler Abbreviated Scale of Intelligence (2nd ed.) (WASI-II) (Minshew et al., 2005) measured as part of the recruitment process. They had adequate reading skills to comprehend the self-assessment process described below, and were able to undertake sufficient self-care and attend a mainstream school, so that their parents described them as 'high-functioning'. All participants were Anglo-Saxon in ethnicity and all had been born in Australia. The parents gave written informed consent for their sons to participate and their sons gave verbal or written assent to participate, depending upon their age. The parents reported that none of their sons had any concurrent genetic or neurological conditions or previous DSM-5 classification of comorbid psychiatric disorder.

2.2. Materials

2.2.1. WASI-II

The WASI-II is a short form intelligence test designed to screen individuals to determine their level of cognitive ability, and which correlates strongly with the Wechsler Intelligence Scale for Children (PsychCorp, 1999). Minshew, Turner, and Goldstein (2005) found good evidence of the scale's predictive validity in individuals with ASD for research applications, supporting its use in the present study. A Full

Table 2
Parent-chosen activities plus ratings (/9) from 1 (Very much preferred) through 5 (Moderately preferred) to 9 (Very much non-preferred).

Non-preferred activity (*n*)	Average parent rating	Preferred activity (*n*)	Average parent rating
Essay/story writing on given topic (13)	7.1	Reading (4)	1.0
Fixing punctuation errors & grammar in set text (11)	8.8	Watching ipad/ You Tube (18)	1.3
Mathematics worksheets (5)	7.3	Electronic games (7)	1.0
	7.8		1.2

Scale IQ score is produced from two composite scales on the WASI-II: Verbal Comprehension and Perceptual Reasoning.

2.2.2. Child and adolescent symptom inventory (4th ed.) (CASI-4)

The CASI-4 consists of 148 items drawn from *DSM-IV* diagnostic criteria for a range of psychiatric disorders (Gadow and Sprafkin, 2010). The subscale relating to Generalised Anxiety Disorder (GAD) was used in the present study as an indicator of the participants' general anxiety status. Responses on the CASI-4 indicate the frequency of symptoms, rated on a four-point Likert scale ranging from 0 (never) to 3 (very often). Gadow and Sprafkin (2010) reported satisfactory internal consistency of the overall scale (r = .74). Prior research has supported the use of the CASI-4 with ASD children (Gadow et al., 2005) and the CASI-4 test manual provides normative data for ASD children (Gadow and Sprafkin, 2010). Some previous research has indicated that the self-reports of anxiety in young people with ASD had stronger agreement with cortisol as a physiological index of anxiety and stress than did their parent's reports of their child's anxiety (Bitsika et al., 2014), and so self-reported data from the young males with ASD on the CASI-4-GAD subscale were utilised in this study as an index of their anxiety.

2.2.3. Self-report inventories

After each boy had concluded the experimental phases described below, the boys and their parents were separately asked to view sections of the visual recording of the experiment and rate the emotional state that the boys were experiencing at the time of the recording. The boys were asked a series of questions about their experiences (see post-experimental debriefing, below).

2.2.4. Heart rate

The boys' ECG was monitored continuously during all phases of the experiment with the Polar Heart Rate Monitor model T34 with chest straps attached to the participant's chest as recommended. The ECG signal was collected every 5 s and fed into PowerLab and processed using LabChart software on a MacBook Air to produce a mean heart rate per 5-second intervals (HR). The Polar HR monitor has been validated against standard ECG electrocardiograph data during rest (r = .987) and seated stressor conditions (r = .990) almost identical with those used in this study (Goodie et al., 2000; Weippert et al., 2010).

2.2.5. Task completion and involvement

(i) Task completion: Each of the boys' tasks was assessed by examination of the products from those tasks, by two raters, blindly, to obtain a 'task completion' score for each boy on each of the three tasks. (ii) Task involvement: the two raters also separately watched segments of the boy's behaviour during the experimental tasks to identify the degree of task involvement each boy exhibited. These procedures are described in detail below.

2.3. Procedure

2.3.1. Experimental conditions

The complete protocol was undertaken by participants in the first author's laboratory at Bond University, set at 21C and 50% humidity. The experimental protocol consisted of a pre-experiment intake, an adaptation phase, four experimental phases, and a post-experiment debriefing phase. Each of these is described below.

2.3.1.1. Pre-experimental intake. Several weeks prior to the experiment, parents were contacted by letter and phone to invite them and their sons to participate in the experiment. If they both agreed, then a researcher went to the participant's home and explained the experimental protocol. If both parent and son agreed to take part in the experiment, then signed consent forms were obtained from both (or verbal assent from the boys who were younger than 12 yr), and the boys were administered the WASI-II and the ADOS-2. The CASI-4-GAD was to be completed on the morning of the child's visit to undertake the experiment. Parents were asked to nominate several preferred and non-preferred activities for the boys to undertake during the experiment.

2.3.1.1.1. Choice of activities. Each parent was asked to nominate three activities for their son for each of the two criteria of: (i) "that your child prefers to do and can maintain with minimal support that allows them to be sedentary" (Preferred activity); and (ii) "that your child does not prefer to do and can maintain with minimal support that allows them to be sedentary (Non-preferred activity). Parents rated each of these nine activities on a 9-point scale from 1 (Very much preferred by your son), through 5 (Moderately preferred) to 9 (Very much non-preferred), and the activities that rated lowest (i.e., most preferred) or highest (most non-preferred) were chosen on an individual participant basis. Table 2 shows these activities and the parents' ratings for them. Although many of the activities were able to be classified as involving common demands, they were all chosen on an individualised basis so that each boy was to be engaged in tasks that were specific to him. The mean parent ratings for each set of activities attest to the relative differences between these activities in terms of their preferred-ness to their sons. Two of the preferred activities that received equal ratings from the parents were chosen for the first two activity phases (i.e., Preferred Activity 1, Preferred Activity 2).

2.3.1.1.2. Experimental protocol. All the following procedures were conducted individually with each participant during the period 1.00 pm to 4.00 pm on separate days but within the same experimental setting.

(1) *Adaptation* (15 min). The Experimenter welcomed participants into the experimental setting, showed them the Polar HR monitor and fitted it, seated the participant and chatted with them while HR data were collected to ensure equipment was working satisfactorily.
(2) *Preferred Activity 1* (10-min). Participants were given the materials for their first Preferred activity and instructed to "Complete this activity now".
(3) *Preferred activity 2* (30 min). Participants were given the materials for their second Preferred activity and instructed to "Complete this activity now". This phase was longer than the first Preferred Activity to enable participants time to immerse themselves in their Preferred Activity rather than the briefer phase *(2)* which was designed to test the effect of being asked to change activity after only a relatively short time.
(4) *Non-preferred activity* (10 min). Participants had their second Preferred activity materials taken from them while the Experimenter said "You are going to stop this activity now". The Experimenter then gave the participants the materials for their Non-preferred activity and said "You are going to complete this activity now". The Experimenter cued participants with the words "You

need to keep going" or "You need to complete this activity" intermittently throughout this 10-min period. This period was reduced in time compared to the Preferred Activity phase so as to reduce the likelihood of major challenging behaviour occurring when the boys were required to change from doing something they liked to something they did not like and forced to remain on this activity for a prolonged period.

(5) *Preferred activity 2* (30 min). Participants had the Non-preferred materials taken from them while the Experimenter said "You are going to stop this activity now". The Experimenter then gave the participants their second Preferred activity materials and said "You are going to complete this activity now". Because this was the last phase in the experiment, participants were given a longer period of time to enjoy their second preferred activity.

2.3.2. Post-experimental debriefing

After these phases were completed, the Experimenter took the Polar chest strap from the participant, gave them a drink of water, and took them to the bathroom. Participants were then asked to sit and watch 30 s of the video recordings of the experiment at each of the following the time periods (i) 8 min into the second 'Preferred Activity' phase, (ii) 7 min into the 'Non Preferred Activity' phase and (iii) 15 min into the 'Preferred activity 2′ phase. Participants were asked the following series of questions about each 30-second videorecorded segment and their answers were recorded for later analysis:

1 What do you believe you were feeling here" (using verbal labels for the emotions of "Nervous or worried", "Scared or frightened", "Annoyed or angry", "Sad or unhappy", "Happy or excited", "Relaxed or calm", plus appropriate emoticon faces depicting these emotions)?
2 "How much (of the boys' identified emotion) do you believe you were feeling?" Boys were asked to point to a place on a 5-point intensity scale ranging from 1 ("Not much"), 3 ("A bit"), to 5 ("A lot").
3 "Why did you feel that way?" Boys' responses were recorded verbatim and later summarised for major themes.
4 "When you look at yourself in this video, is there anything about your (face/body/movement) that shows that you are feeling (stated emotion)?" Responses were recorded verbatim and later summarised for major themes.

The parents were asked the same questions about the same recorded segments, but in the third person and using the same scales and emoticon faces as used with the boys.

After all these stages had been completed, each boy and their parent were thanked for their participation, had any questions answered, and were led to the waiting room where they could leave the building. The study was approved by the Bond University Human Research Ethics Committee Approval No. RO1516.

2.4. Statistical and data analyses

HR data reduction: Polar HR data taken every 5-seconds during all phases were collated into experimental phases and cleaned to remove any artifacts. These data were then compiled into experimental phase means and standard deviation scores to reduce confounds due to momentary fluctuations in heart rate due to physical demands. Using SPSS 23, descriptive statistics were calculated for the HR and other data from the standardised tests, and were analysed for normality. Pearson correlation coefficients were calculated for the associations between age, IQ and dependent variables, and MANOVA with repeated measures tested for the presence of any time-related (phase data) effects. Paired *t*-tests were conducted to test for the presence of a significant change in HR data from phase to phase. All comparisons using multiple tests were corrected via Bonferroni methods, and *a priori* power analysis indicated that the sample size was satisfactory to detect a medium effect size difference in HR across phases ($p < .05$, 95% power). Post-experimental debriefing data were compiled for parents and their sons, and graphs were used to describe the directionality of HR data change across phase pairs.

Because any apparent lack of physiological stressor effects (i.e., expected increases in HR) during the Non-preferred phase might be due to the boys withdrawing from that task, any boys who did not demonstrate the expected HR increase during the Non-preferred task phase had their task data inspected for (a) completion rate (i.e., how much of the task they actually completed), and (b) their task involvement (i.e., how much time they spent on-task). The latter data were calculated from observation of recordings of their behaviour during minutes 3, 5 and 7 of the Non-preferred task. This behaviour was examined by two research staff with PhDs in behaviour analysis. The mean percent they recorded of on-task behaviour was used as the measure of task involvement. Inter-rater agreement was also calculated by the following procedures. Task completion was calculated by reference to the proportion of the boys' Non-preferred task that they completed, classified by two independent raters as either (1) Very low (less than 20%), (2) Moderate (21–50%), or (3) High (51% and above). Task involvement was judged as being on-task for the major part (i.e., > 30 s) during minutes 3, 5, and 7 of the 10-min Non-preferred activity phase. Data were collected by two independent raters who watched videotapes of those three minutes, and who then calculated a percentage 'on-task' value. Inter-rater agreement for both of these tasks was in excess of 98%. These data were then used to provide some indication of whether the boys adopted a coping strategy of behavioural withdrawal when faced with their Non-preferred task.

3. Results

3.1. Group data

Means (SD, ranges) for the sample's age, WASI-II Full Scale IQ, CASI-GAD score, and Heart Rate (bpm) during each experimental phase are shown in Table 1. None of the Kolmogorov-Smirnov statistics were significant, the Normal Q-Q plots approached straight lines, and inspection of the 5% means (Table 1) indicated that outliers did not influence the mean values, allowing the raw data to be used in the following statistical analyses. There was no significant correlation between WASI-II FS IQ and age ($r = -.199$) or CASI-GAD score ($r = .099$), but there a significant inverse correlation between age and CASI-GAD score ($r = -.463$, $p = .008$).

3.2. Heart rate data

At the Bonferroni-corrected alpha level of .05/5 (to account for the repeated HR measures), there were no significant correlations between any of the five sets of HR data from the experimental phases and age, WASI-II FS IQ score, or CASI-GAD score. Thus, the HR data were able to be examined free from the potential confounding effects of age, GAD or IQ. The mean (SE) HR data from each experimental phase are shown in Fig. 1.

MANOVA with repeated measures was conducted on HR data to test for the presence of a significant change in HR over the five experimental phases (including Adaptation), and produced a significant outcome $F(4,25) = 17.517$, $p < .001$, $\mu^2 = .737$. Paired *t*-tests were then conducted to test for the presence of a significant change in HR data from phase to phase, and results are shown in Table 3. Applying the Bonferroni correction for repeated HR measures, significant changes in HR accompanied each of the paired phases apart from Adaptation to Baseline, although all the effect sizes (Cohen's *d*) were close to, or greater than, the value recommended as 'large'(i.e., 0.8 (Cohen, 1988)). There was a significant decrease in HR from the first Preferred activity to the second Preferred activity, suggesting that participants

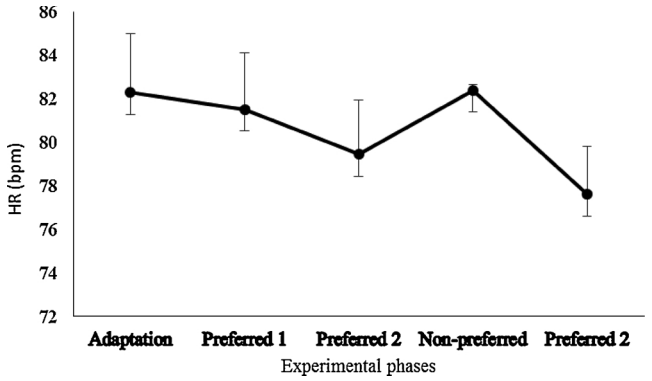

Fig. 1. Mean (SE) heart rate across experimental phases.

Table 3
Paired t-tests of HR across five experimental phases.

Pair	*t*	*p*[1]	Cohen's *d*
Adaptation *vs* Preferred 1	2.065	.048	.780
Preferred 1 *vs* Preferred 2	3.003	.006	1.135
Preferred 2 *vs* Non-preferred	4.252	< .001	1.607
Non-preferred *vs* Preferred 2	8.547	< .001	3.230

[1] Corrected value $p = .01$.

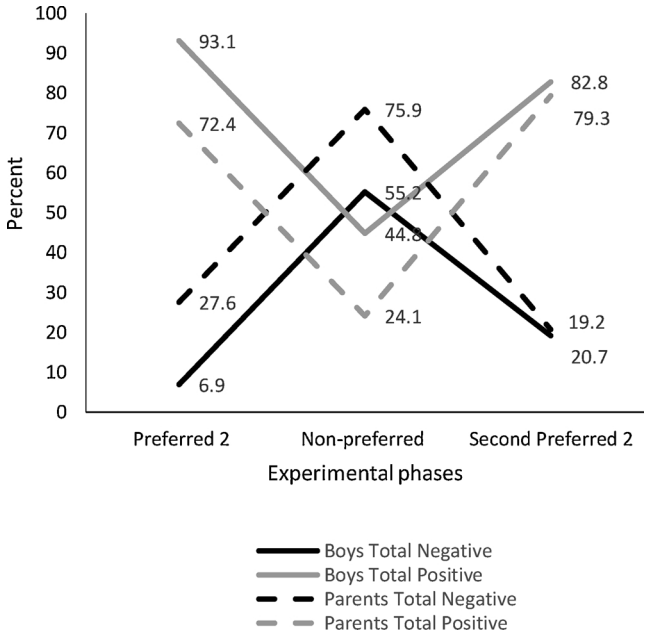

Fig. 2. Boys' and parents' ratings of boys' emotional states over phases.

experienced a reduction in SNS activity when asked to change from one preferred activity to another preferred activity. The change from Preferred 1 to Non-preferred was accompanied by a significant *increase* in HR, whereas the change from Non-preferred to Preferred 2 was a significant *decrease* in HR. This variation in HR according to the various experimental phases is suggestive of a causal link between the type of activity experienced and the SNS responses participants had to those activities.

3.3. Emotion data

As described in the Methods, each boy and his parent (separately) were shown 30-sec segments of video recordings taken near the end of the Preferred 2, Non-preferred, and second Preferred 2 phases. Each parent/son was asked to identify the emotional state of the boys, plus the intensity of that emotional state, and to do so blind to each other's responses. Results are presented in Tables 4 (a) and (b) and indicate that the first Preferred 2 activity phase was generally experienced in a calm or relaxed way by the participants, with agreement between the parents and their sons on these ratings. The Non-preferred phase was rated by the majority of boys as also being associated with them being relaxed or calm, but their parents rated their sons as experiencing nervousness and worry most often. There was general agreement between boys' and parents' ratings for the final preferred activity phase, with most ratings for the relaxed/calm category.

As may be seen from Tables 4 (a) and (b), some specific types of emotional experience were reported by relatively low numbers of boys and parents. Therefore, to more effectively represent the overall reported emotional experience of the boys during the three experimental phases, these data were categorised into "negative" (i.e., nervous/worried, scared/frightened, annoyed/angry, and sad/unhappy) versus "positive" emotions (i.e., happy/excited, relaxed/calm), and are summarised in Fig. 2. The overall agreement between boys and parents about the general type of emotion being experienced by the boys is apparent. Although the difference between positive and negative emotional experiences during the Non-preferred phase is clearer for the parents' data than for the boy's self-reports, the direction of that difference remained consistent across the two rating sources. Also clear was the relative positive versus negative rating difference across all three phases, with both Preferred Activity phases receiving many times more positive ratings than the Non-preferred activity phase, by both parents and sons.

Table 4
(a) Percent of boys' self-ratings of their emotional state across three experimental phases. (b) Percent of parents' ratings of their sons' emotional state across three experimental phases.

(a)

Phase/Rating	Nervous/worried	Scared/frightened	Annoyed/angry	Sad/unhappy	Happy/excited	Relaxed/calm
Preferred 2	7.1	0.0	0.0	0.0	14.3	78.6
Non-preferred	17.2	0.0	31.0	6.9	6.9	37.9
Second Preferred 2	10.3	0.0	6.9	0.0	20.7	62.1

(b)

Phase/Rating	Nervous/worried	Scared/frightened	Annoyed/angry	Sad/unhappy	Happy/excited	Relaxed/calm
Preferred 2	21.4	3.6	3.6	0.0	7.1	64.3
Non-preferred	41.4	6.9	20.7	6.9	3.4	20.7
Second Preferred 2	10.3	0.0	6.9	3.4	13.8	65.5

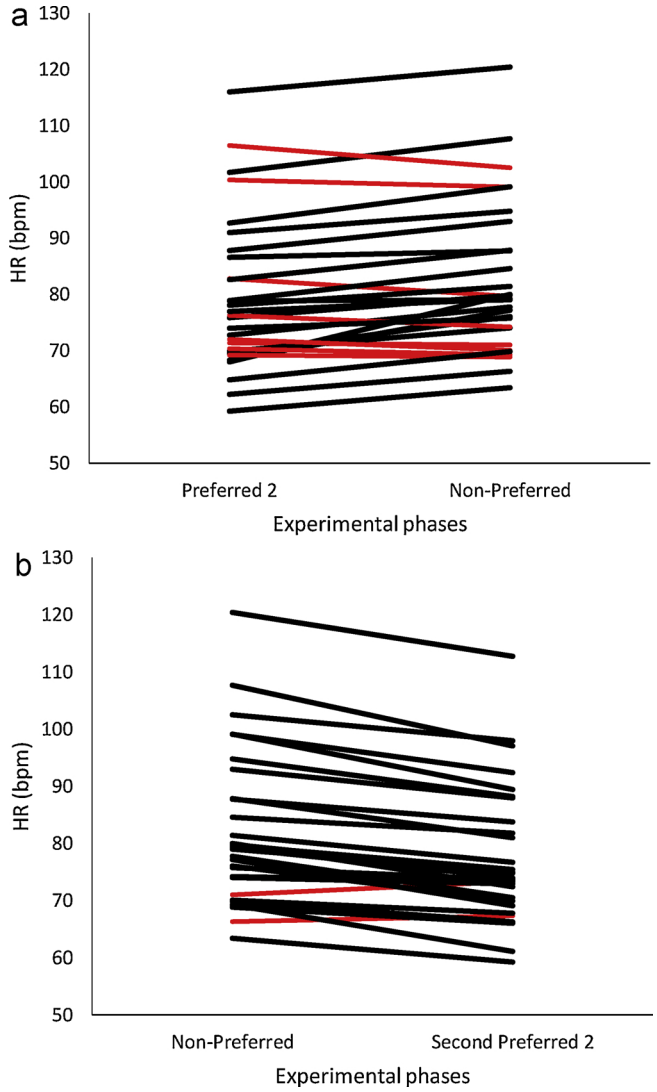

Fig. 3. *(a).* HR changes from Preferred 2 to Non-Preferred (red lines indicate unexpected direction change). *(b).* HR changes from Non-Preferred to second Preferred 2 (red lines indicate unexpected direction change) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

3.4. Individual variability in stress responses

3.4.1. Heart rate

The results reported above are those from the total group of 29 young males with ASD. As such, they inform overall understanding, but they do not highlight individual variations to the group's mean stress responses which may be informative from an experimental and a clinical perspective. Therefore, the HR data (as the prime indicator of stress) were examined for differences in the ways that individual boys responded to the changes from the Preferred 2 to the Non-Preferred phases (Fig. 3 (a)), and from the Non-Preferred to the second Preferred 2 phases (Fig. 3 (b)) respectively. *Expected* changes (i.e., an *increase* in HR during the transition from Preferred 2 to Non-Preferred activity; a *decrease* from the Non-Preferred to the second Preferred 2 activity) are shown in black; *unexpected* changes are shown in red.

For the transition from the Preferred Activity 2 phase to the Non-Preferred Activity phase (Fig. 3a), eight boys (27.6% of the sample) did not show the expected increase in HR, with a mean HR decrease of 1.76 bpm, ranging from -0.35 bpm to -3.96 bpm. By contrast, the 21 boys whose HR increased during this transition had a mean increase of 4.73 bpm, ranging from 0.17 bpm to 12.00 bpm. There were no significant differences in the age, WASI-II FS IQ, Verbal Comprehension and Perceptual Reasoning scores, the four WASI-II subtests of Vocabulary, Similarities, Block Design and Matrix Reasoning that comprise Verbal Comprehension and Perceptual Reasoning respectively, ADOS-2 score, CASI-GAD score, or Baseline HR between these two subgroups of boys (all partial eta squared values for univariate effects were < .02). Neither group showed any significant correlations between their HR change values and their Baseline HR or their HR during the Preferred 2 phase. In addition, there were no significant correlations between HR change during this transition and WASI-II Full Scale IQ, age, ADOS-2 or CASI-GAD total scores and GAD item scores for the eight boys whose HR decreased, but there was an isolated significant direct correlation between WASI-II FS IQ, and HR increase for the boys whose HR responses fitted the expected direction of change ($r = .631$, $p = .002$) at the Bonferroni-corrected p value of $.05/4 = .0125$; the same association for the boys whose HR decreased during this transition was trivial ($r = .001$). The WASI-II FS scores is a combination of the two composite scores for Verbal Comprehension and Perceptual Reasoning: the boys with the expected HR increase during this transition had a significant correlation between that HR increase and Verbal Comprehension ($r = .618$, $p = .003$: corrected p value $.05/5 = .01$), but not for Perceptual Reasoning ($r = .426$, $p = .054$). WASI-II Verbal Comprehension is composed of the Vocabulary and Similarities subtests. When examined at this subtest level, there was a significant correlation (at the corrected level of $.05/2 = .025$) between HR increase and Vocabulary ($r = .602$, $p = .004$) but not for HR increase and Similarities ($r = .458$, $p = .037$).

When asked to transition from the Non-Preferred activity phase to the second phase of their Preferred 2 activity (Fig. 3b), all of the boys except two showed the expected HR decrease. The mean HR decrease during this transition for the 27 boys (93.1% of the sample) whose HR decreased as expected was -5.25 bpm (range = 0.89 to -10.61 bpm); the two boys whose HR increased during this transition did so by 1.02 and 2.32 bpm respectively. There were no significant differences in age, ADOS-2, WASI-II FS or CASI-GAD scores between the two groups (although the large difference in cell size should be considered), and no significant correlations between any of these variables (plus the WASI-II Verbal Comprehension and Perceptual Reasoning scores) and HR decrease for the 27 boys whose HR followed the expected change.

3.4.2. Task completion and involvement

The measures of task completion and task involvement were calculated for those eight boys whose HR showed a change in the opposite direction during the non-preferred phase (i.e., eight boys with HR decreases, shown in Fig. 3 (a)), using procedures described above in Methods. Results are shown in Table 5 and indicate no consistent pattern for either task completion or task involvement. The rates of task completion ranged from Very low to High, and the on-task percentage values ranged from less than 5%–100%. Although it is plausible, these

Table 5
Task completion and task involvement data for eight boys whose HR showed unexpected decreases during their Non-preferred activity phase, plus self- and parent-ratings of sons' apparent anxiety state.

Participant	Task completion (1 = Very low, 2 = Moderate, 3 = High)	Task involvement (percent on-task in minutes 3, 5 and 7)
1	1	10.5
2	2	78.3
3	3	100
4	1	100
5	2	78.3
6	2	75.5
7	1	4.4
8	1	75.5

data do not support the suggestion that these eight participants' HR decreases were an outcome of their withdrawal from the Non-preferred task.

4. Discussion

4.1. Findings

The primary aim of this study was to examine the effects of forced task transition on the stress, emotion, and behaviour responses of boys with ASD; the secondary aim was to test for any effects due to the 'preferedness' of the activities used in the tasks. While there was an expected increase in HR in most of the boys when they were asked to transit from their Preferred activity to the Non-Preferred activity, there was no similar increase in HR activity when they were asked to transit from their Non-preferred activity to their Preferred activity, or from one Preferred activity to another Preferred activity. The isolation of the HR increase (as an index of stress responsivity) to the transition that included a change from a Preferred task to a Non-preferred task suggests that, for these boys, it was the preferedness status of the tasks that was most powerful in eliciting their HR-based stress reaction to task transition.

While these results do not imply that the difficulty that children with ASD experience in making transitions is *solely* an outcome of the preferredness status of the tasks they are asked to undertake, these findings do raise the issue of the proportion of transition-elicited stress responses (that may trigger challenging behaviour) that is due to the ASD-related RRB diagnostic criterion, and that which may be more appropriately assigned to the child's preferences for various activities. If this is the case, then the occurrence of challenging behaviour that often accompanies task changes in young people with ASD in school and similar settings may be a function of both their ASD and also their desire to continue engaging in activities that they like doing.

4.2. Individual data

Not all participants responded consistently to the tasks they were set in this experiment. That is, as has been found in several other studies of the physiological responses to stress observed in boys with ASD (Bitsika et al., 2015; Taylor and Corbett, 2014), there were variations from the group data shown in Fig. 1, with eight (27.5%) of the sample exhibiting the reverse direction HR responses to the change from Preferred 2 to Non-preferred activity. The identification and description of such subgroups of 'atypical' responders among samples of ASD children remains of major importance in research and clinical senses, but the lack of any significant differences in age, IQ, ADOS-2, CASI-4 GAD score or Baseline HR between the 'expected' and 'unexpected' subgroups, leaves open the exact descriptors of these eight boys compared to their 21 peers. A minor suggestion regarding this issue may be taken from the significant correlation between WASI-II Verbal Comprehension Index and HR increase during the transition from Preferred 2 activity to Non-preferred activity for the boys who demonstrated the 'expected' increase (but not for the 'unexpected' subgroup of boys). The WASI-II Verbal Comprehension Index reflects the combined Vocabulary and Similarities subtests of the WASI-II, but only Vocabulary was significantly correlated with HR increase for the 'expected' subgroup. According to the WASI-II Manual (Wechsler, 2011, p. 8), the Vocabulary subtest measures "word knowledge and verbal concept formation…crystalized intelligence, fund of knowledge, learning ability, long-term memory, and degree of language development". In this study, only those boys whose SNS responsivity followed the expected direction of a stress-related increase when asked to transition from a Preferred activity to a Non-preferred activity also showed this (direct) association between the extent of their HR response and their Vocabulary subtest scores, perhaps suggesting that the cognitive skills described above may be involved in their feeling stressed by this transition. Despite there being no significant differences in any of the four WASI-II subtests, their Composite or Full Scale scores between the two subgroups of boys, it appears that there was a difference in the way that one aspect of cognitive ability interacted with SNS HR responsivity for those boys who demonstrated the expected HR increase during stress under the Non-preferred phase.

4.3. Clinical implications

There are two major implications for clinical practice from these findings. First, the difficulty with transitions that is often observed in children with ASD in school settings might not always be legitimately *solely* ascribed to their ASD. Like their non-ASD counterparts, children with ASD have some activities that they prefer and some that they do not like to do. This is a common finding across all humans and needs to be factored into assessments of the challenging behaviour that is observed to follow forced transitions in classrooms and elsewhere. There is no doubt that ASD is strongly associated with rigidity of behaviour, and that this rigidity might trigger challenging behaviour when it is thwarted, but the additional effect of simple preferences for doing certain activities rather than others also needs to be acknowledged. This is not necessarily related to ASD, but the force with which that preferredness may impinge upon the ASD child' emotional and behavioural responsivity (compared to that shown by a non-ASD child) may be an outcome of the nature of ASD. Clinical assessments of transition-related challenging behaviour might be more informative if they include the degree of liking that a child has for a particular behaviour, and the consequent upset that the child may experience when that preferred behaviour is withdrawn from them, rather than focus only upon the ASD-related difficulty in transition *per se*.

Second, the finding that not all boys in the sample responded in the same way when required to transition from preferred to a non-preferred activity clearly emphasises the need to consider this ASD-related trait from the perspective of the individual rather than assume its presence in all children with ASD. That is, because about 25% of this sample of boys with ASD failed to demonstrate the 'expected' HR responses to the stressor of a change from a preferred to a non-preferred activity, it may be that these boys represent a subgroup in the ASD population of young males that could react differently to everyday stressors, particularly in school settings where multiple task changes are common. This suggestion also implies that not all boys with ASD are equally vulnerable to exhibiting stress-related challenging behaviour that is occasioned by task-change demands in their environment, that there may be a link between how these boys respond to such changes in task and their Verbal Intelligence, and that future research is needed to clarify the exact nature of that link, and also to examine other possible predictors of the kind of stress-reactivity subgrouping found here. Some of those potential predictors could include previous training and treatment history, particularly those based upon reinforcement rather than punishment.

4.4. Limitations and strengths

As in all research, there are several limitations on the generalisability of these results. First, the participants were recruited from a specific geographical and cultural region in Australia, and no suggestion is made that boys with ASD from other nations and cultures will respond similarly. Second, the boys were aged between 9 yr and 18 yr, had an IQ $>$ 70, and were all being educated in mainstream schools. Although this selection criteria was applied to ensure that these boys could self-report their emotional state and also that any stress, emotional and behavioural reactions they may have had were not due to a concomitant intellectual disability, extension of this research protocol to girls, to boys and girls of lower IQ, and of younger or older ages, would help in understanding of the findings reported here. Third, as is the case in many experimental studies, data were collected at a fixed

point in time, and no generalisation can be made as to whether the behaviours observed would occur again. Fourth, the decision to provide a reduced length of time for the Non-Preferred activity compared to the Preferred Activity potentially raises the issue of a possible confound between activity and time. However, this decision was made on a clinical basis to attempt to reduce the likelihood of challenging behaviour occurring when the boys were required to cease their Preferred Activity. Fifth, leaving the choice of tasks to the child's parent did not allow for a comparison between parent-chosen versus child-chosen tasks. Although there was a strong rationale for this procedure, comparison of this kind would further inform the current results. In itself, the choice of individualised tasks is both a limit on generalisability to other samples and their preferred and non-preferred tasks, and also a major strength in terms of the validity of those tasks used in this study. Application of a common 'stressor task' such as mental arithmetic or public speaking has the advantage of providing a common stimulus to all participants, but is also limited in the degree to which it represents truly individualised stressor and relaxing tasks. The decision made in this study to individualise the tasks chosen as stimuli was based upon the need to provide a valid set of tasks that could be equated across all participants regardless of their ability in activities such as public speaking and mental arithmetic. Another strength of this study was the use of an experimental protocol that was administered consistently across all participants, thus enabling a greater degree of control upon the experimental stimuli than would be possible via a naturalistic observation study, despite the strengths of the latter. This rigorous experimental control enabled a robust conclusion to be drawn regarding the ways that individual participants responded to the activities they were engaged in during the study. Inclusion of physiological data and observer data as well as self- and parent-reports strengthened the study' ability to produce valid findings.

It should also be reiterated that this study was not designed to test disruption to routine or changes in expectations formed by altered instruction or verbal feedback from an adult that created a change in an expected event from the child's perspective. Those instructional conditions do not represent usual good classroom environments in which teachers strive to initiate positive routines and minimise unexpected changes to avoid additional sources of stress. That is, the present study was designed to mirror the commonly-experienced changes in tasks that occur within a normal (planned) classroom during the day. Disruption to routine or changes in expectations are valid issues for research, but they do not reflect the kinds of demands to change tasks that children should encounter in normal classrooms, which was the focus of this study.

4.5. Conclusions

In conclusion, although these are initial data that need replication and extension, they provide some insight into the effects of task transitions upon the behaviour of boys with ASD. Taking HR as a sensitive indicator of SNS activity in the face of stress, these findings suggest that (a) the behavioural concomitants of task transitions may be associated with a preference to continue with preferred activities as well as the change in activity *per se*, (b) previous reports about the lack of conformity in physiological responses to stress in the young ASD population have been reinforced by the data collected here, and (c) at this time, relatively little is known about why some boys with ASD respond as they do to the onset of a transition stressor. Further investigation of all three of these findings is required before firm recommendations can be made for clinical settings but, on the basis of these findings, the blanket assumption that ASD-related rigidity is the sole cause of unwanted behavioural responses to task transitions is challenged. Instead, like almost anyone, boys with ASD may prefer to do what they like doing.

Conflict of interest

Neither author has any conflict of interest to declare.

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