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An experimental task to measure preschool children's frustration induced by having to wait unexpectedly: The role of sensitivity to delay and culture

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ABSTRACT

The ability to manage frustration induced by having to wait for valued outcomes emerges across childhood and is an important marker of self-regulatory capacity. However, approaches to measure this capacity in preschool children are lacking. In this study, we introduced a new task, the Preschool Delay Frustration Task (P-DeFT), designed specifically to identify children's behavioral and emotional markers of waiting-induced frustration *during* the imposed wait period and *after* the release from waiting. We then explored how waiting-induced frustration relates to individual differences in delay sensitivity and whether it differs between two cultural groups thought to have different attitudes toward children's conduct and performance: Hong Kong (HK) and the United Kingdom (UK). A total of 112 preschool children (mean age = 46.22 months) completed the P-DeFT in a quiet laboratory. Each trial had two stages; first, a button press elicited a *Go signal;* second, this Go signal allowed children to go to a "supermarket" to pick a target toy. On most trials, the Go signal occurred immediately on the first press. On 6 trials, an unexpected/unsignaled 5- or 10-s *pre-Go-signal* period was imposed. Frustration was indexed by performance (button presses and press duration), behavioral agitation, and negative affect during the pre-Go-signal

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wait period and the *post-Go-signal* shopping task. Parents rated their children's delay sensitivity. Waiting-related frustration expressed during both the pre-Go-signal wait period and the post-Go-signal task varied with (a) the length of wait and (b) individual differences in parent-rated delay sensitivity. UK children displayed more negative affect during delay than their HK counterparts, although the relationship between delay sensitivity and frustration was culturally invariant.

Introduction

The development of the ability to regulate emotional responses to frustrating events is essential for social and emotional development during the preschool years (Bell & Deater-Deckard, 2007; Blair, 2002; Brownell & Kopp, 2007; Cole et al., 2011; Stansbury & Sigman, 2000). By the time children start formal education, teachers expect them to be able to self-regulate their behaviors and emotions during periods of frustration (Blair, 2002; Eisenberg et al., 2010; Ursache et al., 2012). A common trigger for frustration among young children is being asked to wait for desired outcomes or events—especially when the waiting period imposed is unexpected (e.g., Calkins, 2007; Cole et al., 2003; Gilliom et al., 2002; Sarafino, 1984). Individual difference in this capacity is an important predictor of interpersonal skills, prosocial behaviors, mental health, early academic success, and self-esteem in later development (Cole et al., 2011; Eigsti et al., 2006; Fabes & Eisenberg, 1992; Fabes et al., 1994; Graziano et al., 2007; Mischel et al., 1988).

Numerous studies have examined children's ability to wait for delayed rewards using paradigms such as the Snack Delay Task and Gift Wrap Task (Breaux et al., 2016; Lin et al., 2019; Pauli-Pott & Becker, 2021; Rademacher & Koglin, 2019; Smith-Donald et al., 2007). They have also examined children's preference for small immediate rewards over larger delayed rewards using tasks like the Maudsley Index of Delay Aversion and the Preschool Choice Delay Task (Antrop et al., 2006; Marco et al., 2009; Pecora et al., 2014; Solanto et al., 2001; Sonuga-Barke et al., 2003). Most of these existing delay tasks have involved a waiting period that was pre-signaled and expectable. Although delay in these settings is likely to induce frustration, we felt that the imposition of unexpected delay would probe frustration to an even greater degree. An innovative delay frustration task was designed by Bitsakou et al. (2006) to explore adults' reactions in the face of unexpected and inescapable delay; however, it was not applicable in the preschool population. To study preschoolers' behavioral and emotional responses during unexpected waiting periods, we developed the Preschool Delay Frustration Task (P-DeFT). In the P-DeFT, the task given to the preschoolers is to press a button to trigger a *Go signal* that allows them to leave their seat and visit a toy supermarket to get a target object. On most trials, the Go signal follows immediately after the first button press. However, on some trials a period of either 5 or 10 s waiting is unexpectedly imposed before the Go signal appears—that is, a *pre-Go-signal* waiting period. On the P-DeFT, waiting-induced frustration is indexed in a number of ways—performance (number and duration of button presses and time used to complete the shopping task), behavioral agitation (actometer-recorded physical activity and observed squirming), and negative affect (observed frustration). Relevant measures are recorded both during the pre-Go-signal waiting period and following the release from waiting, the *post-Go-signal* shopping task.

The P-DeFT builds on the theoretical insights of Amsel's (1958) theory of "frustrative non-reward." This theory predicted frustration effects when a reward is withheld. First seen in studies with rats, these involved the increase of frustration-related activity level and running speed during the period *following* the end of the frustrating event. Amsel and others argued that frustration increases task motivation that facilitates subsequent responses (Dunlap et al., 1974). A similar phenomenon has been seen in preschool children—with increased speed in lever pressing following non-reward trials (Penney, 1960; Ryan & Watson, 1968).

In this study, we used the P-DeFT to test four main hypotheses. First, in line with Amsel's (1958) model, we hypothesized that waiting-related frustration would be seen *both* during the imposed waiting period and after it (i.e., when children are released from waiting).

Second, we hypothesized that frustration would vary as a function of the length of that waiting period. Third, we hypothesized that it would be greater in children who are rated as being more delay sensitive in general. The second and third hypotheses were based on Sonuga-Barke's (1994) observation that some children are especially sensitive to the experience of delay when waiting for outcomes—a motivational orientation he termed *delay aversion*. This leads children to try to escape from the delay (Sonuga-Barke et al., 1992a, 1992b). When possible, delay-averse children choose the lesser delay even if that means sacrificing rewards (Sonuga-Barke et al., 1994). Sonuga-Barke argued that when delay is inescapable, as is the case with the new task here, children try to reduce the perceived duration of delay by increasing activity and engaging in stimulus-seeking behaviors (Sonuga-Barke et al., 1992a). Consistent with this view, existing research has found that common reactions by children during pre-reward delay include terminating their wait sooner (Paloyelis et al., 2009), applying strategies like distraction and bidding to adults (Gilliom et al., 2002; Mischel & Mischel, 1983; Ratcliff et al., 2021), and expressions of negative emotions (Cole et al., 2011; Dennis et al., 2009). However, the proposed relationship between delay duration and levels of frustration has rarely been tested in the preschool population, perhaps due to the fact that most existing delay discounting tasks are hypothetical-based, with choices of a range of reward size and waiting interval up to month(s), which makes them difficult for preschoolers and younger children to comprehend (Sjöwall et al., 2013). To test the second and third hypotheses, we varied the length of the unexpected waiting period and also asked parents to rate their children's delay sensitivity.

Fourth, we hypothesized that levels of delay sensitivity and expressions of waiting-related frustration would be lower in cultures with stricter views on the need for children's self-control. Cultures vary in their expectations relating to children's behavior in general and to self-regulation in particular. For instance, the culture in East Asia places great value on the control of behaviors and suppression of emotional expression in general and also emphasizes patience during waiting situations in particular (Chao, 1994, 1995; Chen, 2005; Lam & Ho, 2010; Thompson et al., 2017). Indeed, in a recent cross-cultural study, Chan et al. (2022) found that the observed behavioral agitation of Hong Kong (HK) children, as indicated by the objectively measured activity level, was lower than that of their United Kingdom (UK) counterparts, but their parents rated them as more hyperactive. Therefore, in the current study, apart from looking at the cultural differences in children's performance and reactions during the new version of the delay frustration task, we also explored the impact of culture on the relationship between parent ratings of children's delay sensitivity and children's actual performance. We expected HK children to show less delay-related frustration on the task but to be rated by their parents as being more delay averse than their UK counterparts. In contrast, we also hypothesized that the positive relationship between delay sensitivity and expression of frustration during delay would be similar across cultures.

Research questions

We addressed three research questions:

1. Do children's levels of frustration in the P-DeFT increase as a function of the length of the waiting period's duration—0 vs. 5 vs. 10 s—in terms of performance, behavioral agitation, and negative affect? Are these effects seen both during the imposed pre-Go-signal waiting period and during the post-Go-signal shopping task afterward?
2. Are children's levels of frustration in the P-DeFT and the differences found between short and long waiting periods related to individual differences in delay sensitivity as rated by parents?
3. Do children's levels of rated delay sensitivity and waiting-related frustration differ between UK and HK participants? Does the strength of association between rated delay sensitivity and frustration expression on the P-DeFT differ in the UK and HK samples?

Our specific predictions based on an integration of the delay aversion (Sonuga-Barke et al., 1992a, 1992b, 1994) and frustrative non-reward (Amsel, 1958) theories were as follows:

1. Children will display higher levels of frustration on the long-delay trials, compared with the short-delay trials, in terms of elevated rates of button pressing, greater behavioral agitation, and more negative affect during the pre-Go-signal waiting periods and higher levels of post-Go-signal activity during the shopping task.
2. There will be a positive correlation between parent ratings of delay sensitivity and children's frustration expression on the P-DeFT—with effects exacerbated on the longer delays.
3. UK participants will display higher levels of frustration in the P-DeFT than HK participants, whereas the parent-rated delay sensitivity will be higher in HK participants.

Method

Participants

Participants in this study were recruited via local nurseries, preschools, and online parent groups using social media advertisements in London (UK) and Hong Kong. A total of 189 preschool children and their parents gave their consent to participate in the initial screening (UK: $n = 68$, 51% male; HK: $n = 121$, 58% male).

The screening questionnaires completed by teachers and parents provided basic demographic information of the child participants, whether the children had a diagnosis of special educational needs and/or pervasive developmental disorders (e.g., autism spectrum disorder), and their primary language spoken at home and at school. A total of 30 children (UK: $n = 13$; HK: $n = 17$) were excluded; of these, 5 were outside the age range, 1 had an existing diagnosis, 21 were without teachers' data on the screening questionnaire, and 3 had families that were unable to attend the session. No one was excluded for low IQ (<80) or being unable to comprehend spoken English (UK) or Cantonese (HK).

The performance indicators of the P-DeFT include the measure of physical activity and waiting-related responses that have previously been found to be associated with attention-deficit/hyperactivity disorder (ADHD; Patros et al., 2016; Pauli-Pott & Becker, 2021; Sonuga-Barke et al., 2008). To allow us to compare like with like across cultures and minimize confounders in our analysis of cultural differences in delay frustration, participants in the UK and HK were matched for age, sex, and their levels of activity and attentional symptoms rated on the five-item hyperactivity/inattention subscale of the Strengths and Difficulties Questionnaire (Version T2-4) completed by parents and teachers. We oversampled participants and then excluded 47 in order to balance the HK and UK samples in the three aspects described at a group level.

The mean ages of children in the final UK and HK samples were 46.55 and 45.85 months, respectively, with no significant statistical difference between groups, $F(1, 110) = 0.41$, $p = .526$. The sex ratio and initial levels of hyperactivity/inattention symptoms rated by parents and teachers were not significantly different, $\chi^2(1, 112) = 0.13$, $p = .721$ and $F(1, 110) = 2.33$, $p = .130$, respectively. No children had been formally diagnosed with ADHD, and none was taking ADHD medications. Full data were available for 112 children (UK: $n = 55$; HK: $n = 57$; 49 female and 63 male).

The authors assert that all procedures contributing to this work complied with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. This study was reviewed and approved by research ethics committees of the University of Hong Kong and King's College London. Informed consent was obtained for all individual participants included in the study.

Measures

Screening measures

Inattentive and overactive behaviors screener. The parent and teacher versions of the Strengths and Difficulties Questionnaire (Version T2-4), a widely used, psychometrically strong, brief screening questionnaire designed for research/clinical purposes, were used (Goodman, 1997). The hyperactivity/inattention subscale consists of 5 items, with 2 items measuring inattention, 2 items measuring hyperactivity, and 1 item measuring impulsivity. The original English language version was used in the UK. A validated Chinese translation was used in HK (Lai et al., 2010).

Intelligence. Children's IQ was estimated using the Block Design and Vocabulary subtests of the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 2003), which measures the cognitive ability of preschoolers and young children aged 2 years 6 months to 7 years 3 months. The English (UK) and traditional Chinese language versions were used in the UK and HK, respectively.

Preschool Delay Frustration Task

The P-DeFT was developed based on the Delay Frustration Task created by Bitsakou et al. (2006) to measure children's responses when the continuous presentation of a simple rewarded task was unexpectedly interrupted. The P-DeFT was designed in a simplified form for the preschool-age population; it was introduced to the participants as a fun and easy way to engage with a "shopping" game where they had to cross the road to visit a toy supermarket (as illustrated in Fig. 1). In each trial of the game, the participants were presented with a red *Wait* signal and then asked to complete a two-stage task: (a) to press a "crossing" button positioned at the side of their chair to change that signal to a green *Go signal* and then (b) to complete a shopping task at the toy supermarket that involved locating an object shown by the experimenter on a shopping card. The only rule of the game for participants was to wait for the red Wait signal to change to a green Go signal before going to find the item.

There were 18 trials in total (three conditions: no delay, 5-s delay, and 10-s delay). In the majority of trials, the green Go signal was shown immediately after children pressed the crossing button (i.e. no *pre-Go-signal* delay). In 6 trials, a pre-Go-signal waiting period was imposed (by either 5 or 10 s; 3 trials each). To account for the potentially confounding effects of fatigue and boredom across trials, we presented the 5- and 10-s-delay trials in a pseudorandom order. During this period, the Wait signal continued to be shown until the waiting time was up. Participants were not informed before the start

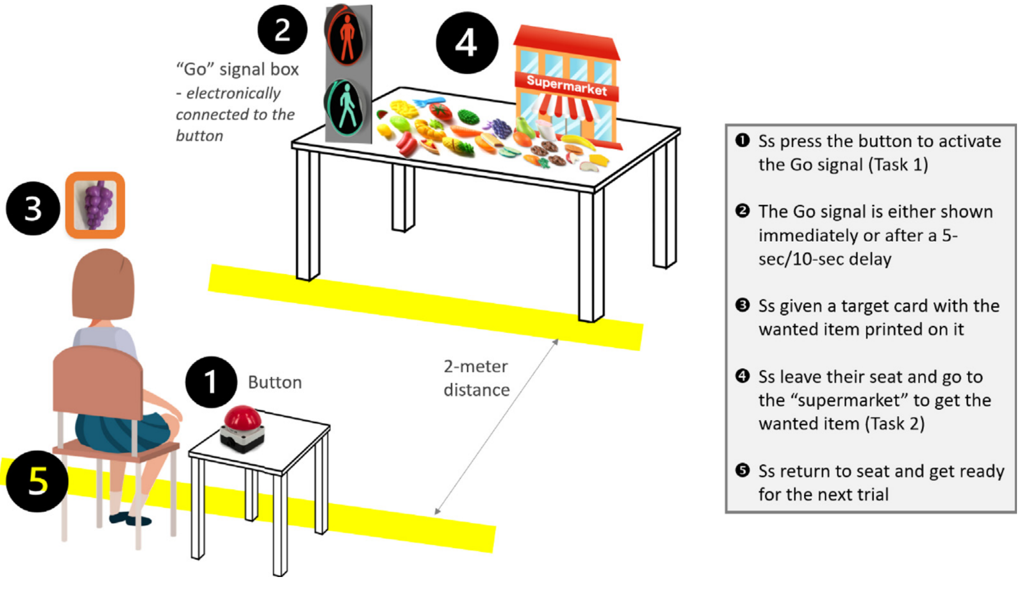

Fig. 1. Setup and procedures of the Preschool Delay Frustration Task (P-DeFT). In the P-DeFT, participants were shown a pedestrian traffic light system, then in each trial they had to (1) press the button, and (2) when the light turned green (immediately or after a short period of delay), they would be (3) shown a shopping card. After that, they could (4) go to the supermarket to pick up the toy and then (5) return to their seat.

of the task about the presence of these waiting periods but were told that the crossing button was rather old and might occasionally be a bit slow to work.

To make sure that the children's frustration was related specifically to the waiting period rather than task difficulty or the amount of rewards received, we designed the shopping task to be easy to complete (all target items were highly distinguishable and the difficulty to pick correct items was very low), fun, and motivating, with correct responses being rewarded with praise. In the briefing before the trials, participants were told that getting all the correct items from the supermarket would result in stickers being rewarded on game completion. All participants in this study got all the shopping trials correct and therefore received all rewards available. Although children were reminded in the prestudy briefing to return to their seat as soon as they selected the item, they were not prompted to sit down once the game had started; this allowed activity and time used in the shopping task to be measured. The complete administration of the P-DeFT lasted about 5 to 15 min, much dependent on the children's efficiency in the shopping task.

The number and duration of participants' button presses during the pre-Go-signal waiting periods, which were intended to index participants' attempts to end the waiting period, were recorded electronically. Participants' activity levels during the pre-Go-signal waiting period and the *post-Go-signal* shopping task were recorded using a professional-grade actigraph unit (see description in next section). The time used to complete the shopping task was computed by extracting the start and end times of participants' moves from the output file.

Participants' negative affect (frustration as indicated by frowning, sighing, and pouting) and behavioral agitation (squirming and fidgeting) during the 5- and 10-s delays were also observed and coded using a 4-point scale. The details of the observation coding are presented in the following. Other measures coded were heavily skewed toward zero and so were not used in the analysis (see Table A1 in the Appendix A).

All task measures had adequate internal consistency ($\alpha s \geq .89$) and good test–retest reliability ($rs \geq .75$).

Activity level

Activity was measured using an unobtrusive wrist-worn activity tracker. This was a validated, wearable, CE (*conformité européenne*) marked actometry sensor (a small actigraph unit). The safety of the device was tested extensively and approved for use by regulatory authorities. The device measured changes in acceleration over short intervals of time (actigraphy). The data output was average *G* (a measure of acceleration recorded by the motion sensor signal sampled at 6.5 Hz) for each second.

Observation coding

Participants' waiting-related frustration as expressed in terms of behavioral agitation and negative affect were coded for each of the 6 delay trials in the P-DeFT by two separate coders. All the sessions were videotaped, and all the records were double-coded and rated by at least two trained coders, who used videos from the pilot data and reached a 90% consensus prior to the official video coding. The cues for frustration were (a) behavioral agitation (squirming and fidgeting) and (b) negative affect (frowning, sighing, and pouting). Coders were instructed to take the duration of wait into account and code each of the behavioral cues using a 4-point scale with 0 = *none/very rare* (0%–10% of time), 1 = *a little* (11%–25% of time), 2 = *quite a lot* (26%–50% of time), and 3 = *a lot* (>50% of time). Inter-rater reliability, as in intraclass correlations (ICCs), was calculated to determine whether there was significant agreement between raters. The ICCs for the behavioral agitation codes were .92 or higher (average = .95), whereas the ICCs for the negative affect codes were .94 or higher (average = .95), indicating very good agreement between the raters.

Delay sensitivity ratings

The Quick Delay Questionnaire was originally designed to measure adults' self-reported delay-related behaviors (Clare et al., 2010). Markomichali (2015) adapted it to be used for preschoolers and rated by teachers or parents. There were two subscales (5 items in each): (a) Delay Aversion (e.g., "I hate waiting for things") and (b) Delay Discounting (e.g., "I often give up on things I cannot have immediately"). The 10 items were rated on a 5-point Likert scale from 1 = *not at all like him/*

her to 5 = *very much like him/her.* The scale has high internal consistency (α = .84) and good test–retest reliability (r = .75). Study data are available on request from the corresponding author (E.S-B.).

Procedure

Invitations and study information were sent to parents via local nurseries, preschools, and parent communities. Participants were included or excluded based on the results of screening questionnaires completed by teachers and parents who consented to participate. Selected parent–child dyads were invited to attend an in-person testing session administered at the university by trainer researchers (one in each university at King's College London and the University of Hong Kong). On the testing day, researchers explained to participants the procedures of the session, answered their questions, and affirmed their right to participate and withdraw voluntarily. The sessions took place in quiet rooms with children's tables and chairs, computer, and screen available. After some time to warm up, if a child agreed, the parent would leave the room and fill in questionnaires in a separate area while the researcher would administer the P-DeFT to the child. Participants consented for the sessions to be video-recorded.

Data analysis

Preparatory analyses

We first conducted analyses to compare the demographic characteristics of the UK and HK samples. We then examined whether there were age, sex, IQ, and family income effects on the delay sensitivity ratings and P-DeFT measures using analysis of variance (ANOVA), chi-square test, and correlational analyses. Corrections for multiple testing were made using the Bonferroni formula. Confounding variables, if any, were controlled for in the subsequent analyses.

Core analyses

The first part of the analysis plan focused on the impact of delay duration and delay sensitivity on participants' performance and reactions in the P-DeFT in the full sample. Repeated-measures ANOVAs were conducted to test whether indices of waiting-related frustration were different in trials with and without imposed waiting and in 5- and 10-s-delay trials. Correlational analyses were then used to explore the relationship between parent-rated delay sensitivity and participants' waiting-related frustration. Difference scores were computed to estimate participants' change in frustration between short and long waiting trials and to examine their relations with rated delay sensitivity. Following these, the second part of the analyses focused on the between-nation differences. We ran ANOVAs to test whether UK and HK children differed in their rated delay sensitivity and P-DeFT responses, and subsequently the PROCESS macro test of moderation (Model 1, 5000 bootstrap samples), to explore whether the relationship between delay sensitivity and P-DeFT measures was moderated by national group.

Results

Table 1 presents the demographic characteristics of participants in the UK and HK. The two national groups did not differ significantly in age, sex ratio, IQ, and family household income.

Table 2 presents the correlations between IQ, age, parent-rated delay sensitivity, and P-DeFT measures. Time used to complete the post-Go-signal shopping task on the delay trials was negatively associated with participants' IQ and age. Time used to complete the task on the no-delay trials was negatively associated with age. IQ and age were subsequently controlled for as confounding variables. Meanwhile, there were no significant sex or family income differences in the outcomes measures (see Table A2 in the Appendix A).

Table 3 shows the comparison of participants' performance in the pre-Go-signal waiting period and the post-Go-signal shopping task in trials with different waiting durations.

Table 1
Demographic characteristics of participants in UK and HK

	UK (*n* = 55)	HK (*n* = 57)	Statistical comparison
Age (months) [mean (*SD*)]	46.55 (6.49)	45.86 (4.91)	$F(1, 110) = 0.41$, $p = .526$
Female [*n* (%)]	25 (45.45)	24 (42.11)	$\chi^2(1) = 0.13$, $p = .721$
IQ [mean (*SD*)]	108.72 (12.20)	105.26 (10.69)	$F(1, 109) = 2.53$, $p = .114$
Monthly household income [*n* (%)]			
Below £2000	4 (7.27)	6 (10.53)	
£2000–£2999	1 (1.82)	7 (12.28)	
£3000–£3999	8 (14.55)	8 (14.04)	$\chi^2(3) = 5.33$, $p = .149$
Above £4000	42 (76.36)	36 (63.16)	

Table 2
Correlations between IQ, age, delay sensitivity ratings, and Preschool Delay Frustration Task measures

			IQ	Age
1	Parent-rated delay sensitivity		–.15	.08
2	During pre-Go waiting	Number of button presses	.03	–.06
3		Duration of button press	.01	–.22
4		Activity measured	–.04	–.13
5		Behavioral agitation	–.05	–.13
6		Negative affect	.01	.03
7	Post-Go task (no-delay trials)	Activity measured	–.03	.03
8		Time used in task completion	–.18	–.37**
9	Post-Go task (delay trials)	Activity measured	–.02	–.05
10		Time used in task completion	–.30*	–.36**

Note. pre-Go waiting, pre-Go-signal waiting period; post-Go task, post-Go-signal shopping task. Number of button presses, duration of button press, and activity measured were computed as units per second. Behavioral agitation and negative affect (fidgeting and facial expression of frustration) were coded using a 4-point scale. The unit of time used in task completion was seconds (s).
* $p < .007$.
** $p < .001$ (adjusted *p* values based on Bonferroni correction).

In comparing participants' responses in the 5- versus 10-s-delay trials, analyses showed that participants' behavioral agitation and negative affect during the delay, as well as their level of activity and the amount of time used in the post-Go-signal shopping task, were greater in the 10-s-delay versus 5-s-delay trials; that is, participants were more frustrated, exhibited higher levels of movement, and took longer to complete the task in the trials with longer versus shorter delay. The comparison is visualized in Fig. 2.

In comparing participants' responses in delay versus no-delay trials, time used to complete the task in the 5-s-delay trials was significantly greater than that in the no-delay trials ($F = 26.73$, $p < .001$), whereas both participants' level of activity ($F = 32.71$, $p < .001$) and time used to complete the task ($F = 47.66$, $p < .001$) in the 10-s-delay trials were significantly higher than that in the no-delay trials.

Table 4 shows the association between delay sensitivity ratings and the P-DeFT responses in trials with different delay duration, controlling for participants' age and IQ. Delay sensitivity ratings were not correlated with any measures in the no-delay trials. In contrast, delay sensitivity was significantly correlated with participants' behavioral agitation and negative affect during the pre-Go-signal waiting period as well as their level of activity in the post-Go-signal shopping task in both the 5- and 10-s-delay trials (*r*s $\geq .30$, $p \leq .002$).

To further explore how delay sensitivity ratings were associated with participants' change in frustration between short- and long-delay trials, subsequent correlational analyses between delay sensitivity and difference scores were conducted (Table 5), and results showed that delay sensitivity was significantly associated with the differences between participants' post-Go-signal shopping task responses in no-delay and 10-s-delay trials (*r*s $\geq .30$, $p \leq .002$). The differences between participants'

Table 3
Comparison of Preschool Delay Frustration Task responses in trials with different waiting durations

		Condition						Statistical comparison	Pairwise contrasts
		No delay (1)		5-s delay (2)		10-s delay (3)			
		M	*SD*	*M*	*SD*	*M*	*SD*		
During pre-Go-signal waiting period									
1	Number of button presses	Not applicable		0.83	0.34	0.80	0.36	$F = 1.52$	Not applicable
2	Duration of button press			2.59	2.90	2.82	2.57	$F = 2.45$	
3	Activity measured			152.97	57.29	149.10	61.24	$F = 0.82$	
4	Behavioral agitation			2.03	0.91	2.34	1.00	$F = 43.61^{***}$	
5	Negative affect			1.34	0.52	1.62	0.70	$F = 49.45^{***}$	
During post-Go-signal shopping task									
6	Activity measured during task	284.07	58.63	282.29	63.72	310.21	71.85	$F = 25.00^{***}$	$1 < 3^{***}$, $2 < 3^{***}$
7	Time used in task completion	13.43	3.26	15.16	5.02	16.36	6.15	$F = 34.06^{***}$	$1 < 2^{***}$, $1 < 3^{***}$, $2 < 3^{***}$

Note. Number of button presses, duration of button press, and activity measured were computed as units per second. Behavioral agitation and negative affect (fidgeting and facial expression of frustration) were coded using a 4-point scale. Activity measured was computed as units per second. The unit of time used in task completion was seconds (s).
*** $p < .001$.

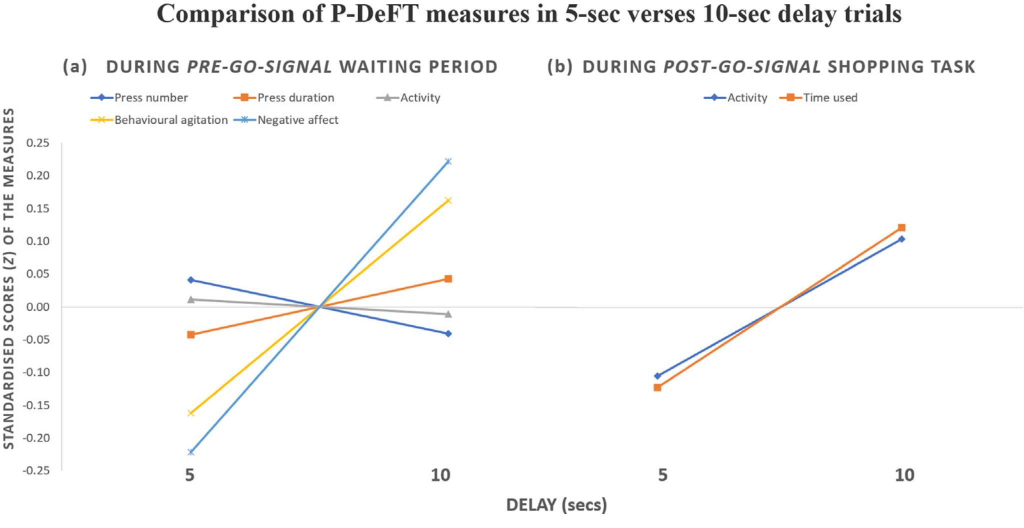

Fig. 2. Comparison of Preschool Delay Frustration Task (P-DeFT) responses in 5-s-delay versus 10-s-delay trials. (A) During the pre-Go-signal waiting period, participants' behavioral agitation and negative affect were greater in the 10-s versus 5-s delay trials. (B) During the post-Go-signal shopping task, participants' activity level and time used in the task were also greater in the 10-s versus 5-s delay trials.

responses in short- and long-delay trials, however, were not significantly correlated with their parent-rated delay sensitivity.

Table 6 compares the UK and HK participants' delay sensitivity ratings and P-DeFT responses. It shows that the two groups differed significantly only in the negative affect observed during the waiting period, with UK children appearing more frustrated than HK children ($F = 20.89$, $p < .001$). The same pattern of results was found in separate analyses of the 5- and 10-s-delay conditions.

Table 4
Correlations between delay sensitivity ratings and Preschool Delay Frustration Task responses in trials with different waiting durations, controlling for participants' age and IQ

Individual scores			Delay sensitivity ratings			
			No delay	Delay (average)	5-s delay	10-s delay
1	During pre-Go waiting	Number of button presses	Not applicable	.07	.05	.09
2		Duration of button press		.19	.18	.19
3		Activity measured		.23	.20	.23
4		Behavioral agitation		.34**	.34**	.31*
5		Negative affect		.33**	.31*	.31*
6	During post-Go task	Activity measured	.14	.32**	.30*	.31*
7		Time used in task completion	−.06	.21	.15	.25

Note. pre-Go waiting, pre-Go-signal waiting period; post-Go task, post-Go-signal shopping task. Number of button presses, duration of button press, and activity measured were computed as units per second. Behavioral agitation and negative affect (fidgeting and facial expression of frustration) were coded using a 4-point scale. The unit of time used in task completion was seconds (s).
* $p < .007$.
** $p < .001$ (adjusted p values based on Bonferroni correction).

Table 5
Correlations between delay sensitivity ratings and difference scores computed between Preschool Delay Frustration Task responses in trials with different waiting durations, controlling for participants' age and IQ

Difference scores			Delay sensitivity ratings		
			0 s vs. 5 s	0 s vs. 10 s	5 s vs. 10 s
1	During pre-Go waiting	Number of button presses	Not applicable	Not applicable	.07
2		Duration of button press			−.02
3		Activity measured			.07
4		Behavioral agitation			.02
5		Negative affect			.15
6	During post-Go task	Activity measured	.25	.30*	.07
7		Time used in task completion	.25	.37**	.24

Note. Difference scores were computed by deducting the Preschool Delay Frustration Task response scores of short-delay trials from those of long-delay trials. pre-Go waiting, pre-Go-signal waiting period; post-Go task, post-Go-signal shopping task. Number of button presses, duration of button press, and activity measured were computed as units per second. Behavioral agitation and negative affect (fidgeting and facial expression of frustration) were coded using a 4-point scale. The unit of time used in task completion was seconds (s).
* $p < .007$.
** $p < .001$ (adjusted p values based on Bonferroni correction).

Despite such difference in negative affect, the PROCESS macro test of moderation showed that the relationship between delay sensitivity and negative affect observed during the delay was not significantly moderated by national group ($B = -.20$, $t = -1.22$, $p = .225$). Table 7 shows the interaction effects between national group and delay sensitivity ratings on participants' P-DeFT responses, all of which were not significant (ts ≤ 1.74, ps $\geq .086$).

Discussion

Preschool children's ability to regulate their emotional and behavioral responses to frustration can predict their future socioemotional development (Cole et al., 2011; Eigsti et al., 2006; Fabes & Eisenberg, 1992; Fabes et al., 1994; Graziano et al., 2007; Mischel et al., 1988). Having to wait for desired outcomes is a particularly powerful source of frustration, but little is known about how increasing the length of the waiting period before the eventual delivery of the reward affects frustration levels either during or after the imposed wait. The roles of delay sensitivity and cultural background in determining waiting-related frustrations are also yet to be explored. In this study, we used the P-DeFT to examine these questions. There were a number of findings to note.

Table 6
Main effects of national group on delay sensitivity ratings and Preschool Delay Frustration Task responses

		United Kingdom			Hong Kong			Statistical comparison		
		M	*SD*	*n*	*M*	*SD*	*n*	*F*	*p*	η^2
Parent ratings on										
1	Children's delay sensitivity	2.84	0.70	55	2.94	0.48	57	0.78	.378	.01
During pre-Go-signal waiting period										
2	Number of button presses	0.83	0.36	54	0.80	0.30	57	0.31	.582	.00
3	Duration of button press	2.82	2.73	54	2.60	2.54	57	0.20	.657	.00
4	Activity measured	159.42	53.68	53	142.95	55.53	55	2.45	.120	.02
5	Behavioral agitation	2.20	0.93	55	2.17	0.92	57	0.03	.875	.00
6	Negative affect	1.72	0.66	55	1.25	0.37	57	20.89	<.001	.16
During post-Go-signal shopping task (no-delay trials)										
7	Activity measured	286.88	62.32	53	281.36	55.29	55	0.24	.627	.00
8	Time used in task completion	13.12	2.65	55	13.72	3.74	57	0.97	.327	.01
During post-Go-signal shopping task (delay trials)										
9	Activity measured	299.98	69.34	53	292.65	57.94	55	0.36	.552	.00
10	Time used in task completion	15.41	4.23	55	16.10	6.32	57	0.45	.502	.00

Note. Number of button presses, duration of button presses, and activity measured were computed as units per second. Behavioral agitation and negative affect (fidgeting and facial expression of frustration) were coded using a 4-point scale. The unit of time used in task completion was seconds (s).

Table 7
Interaction effects of national group and delay sensitivity on Preschool Delay Frustration Task responses

Interaction effects of national group and delay sensitivity on:		Coefficient	Standard error	Statistic	Significance level	95% bootstrapping confidence interval	
		B	*SE*	*t*	*p*	LLCI	ULCI
During pre-Go-signal waiting period							
1	Number of button presses	0.19	0.11	1.74	.086	−0.03	0.42
2	Duration of button press	−0.30	0.88	−0.34	.737	−2.05	1.45
3	Activity measured	7.45	19.06	0.39	.697	−30.34	45.24
4	Behavioral agitation	−0.16	0.30	−0.54	.591	−0.75	0.43
5	Negative affect	−0.20	0.17	−1.22	.225	−0.54	0.13
During post-Go-signal shopping task (no-delay trials)							
7	Activity measured	13.88	20.85	0.67	.507	−27.47	55.24
8	Time used in task completion	1.03	1.11	0.93	.353	−1.16	3.23
During post-Go-signal shopping task (delay trials)							
9	Activity measured	2.82	21.68	0.13	.897	−40.18	45.81
10	Time used in task completion	0.60	1.81	0.33	.741	−2.98	4.18

Note. LLCI, lower limit of confidence interval; ULCI, upper limit of confidence interval.

First, consistent with the delay aversion theory, children's waiting-related frustration was greater on trials with imposed pre-Go-signal delay than on those without it. Frustration also increased in intensity as waiting periods were increased from 5 to 10 s. These results highlight just how sensitive preschool children are to delay when frustrated given that the two delay intervals differed by only 5 s. This highlights how important it is for researchers to take into account even small differences in delay when interpreting findings in this age group.

Second, the duration of the waiting period affected children's expressions of frustration both during *and* after the waiting interval in terms of activity and time used in the post-Go-signal shopping task. At first sight, this post-Go-signal effect might appear to support Amsel's (1958) model of frustrative non-reward, but a closer look reveals the opposite to be the case. Amsel's view was that the delivery of reward after a period of frustration was positively motivating in terms of subsequent activity and running speed (Amsel, 1958; Dunlap et al., 1974); however, the current results in fact showed that the frustrative effect was disruptive. Children displayed a higher level of activity and took longer to complete the shopping task after the long versus short pre-Go-signal waiting period. In the past, the delay aversion model has focused exclusively on children's responses during delay. The current findings demonstrated that the negative effects of delay extend to after the imposed delay is terminated and extend the delay aversion concept in important ways.

There are several explanations of this post-delay response disruption after the experience of frustration. From a *delay aversion hypothesis* perspective, it may be that children were taking longer to complete the task because they were trying to avoid going back to the frustrating delay situation in the next trial. By contrast, the *surplus energy theory* suggests that the additional activity and time spent on the post-delay task might have been compensation for the frustration and boredom they experienced during the delay—leading to the buildup of surplus energy—that had to be expended (Pellegrini & Smith, 1993). It may also be possible that frustration, instead of energy, was accumulated during the inescapable waiting period and that some children, particularly those with higher delay sensitivity, may have greater needs to compensate or release their frustration in the form of activity and free movements. Finally, individual differences have been found in young children's rate of recovery from frustration (Kahle et al., 2016; Northrup et al., 2020; Santucci et al., 2008). A neurological study (Brown et al., 2021) also found that some children had greater difficulty in regulating their emotion expression evident in their neural activity (especially the P3 area that is responsible for attention allocation) during the period following a frustrative event. The authors of that study suggested that there were carryover effects of frustration and some children experienced particular challenges in recovering from frustrating events, and this difficulty was found to be associated with future psychological difficulties. The current findings call into question whether the more delay-sensitive children have greater difficulty in recovering from the waiting-related frustrations.

The third finding was that parents' ratings of delay sensitivity correlated with individual differences in waiting-related frustration expression. On the one hand, these findings provide a degree of validation of the Quick Delay Questionnaire as a measure of children's sensitivity toward delay; on the other hand, they highlight its potential value as a measure of longer-term risk for negative socioemotional outcomes. Future studies should address this point using longitudinal data. Interestingly, there was no evidence that a higher level of delay sensitivity was associated with greater differences between short- and long-delay trials in children's responses *during* the waiting delay. There was, however, evidence that a higher level of delay sensitivity was associated with greater frustration differences between short and long delays in their post-delay performance *after* it—a higher intensity of activity and lower efficiency in the 10-s condition. This again refocuses attention of accounts of delay aversion to the post-delay period rather than the during-delay period.

Fourth, as hypothesized, UK participants expressed stronger negative affect during the delay. The relationship between delay sensitivity and all the P-DeFT measures was, however, invariant across nations. This means that although there were predictable differences between the children in absolute terms, nevertheless these measures appeared to have similar predictive value in both cultures. Again, longitudinal research will be important in addressing this.

The current study had a number of strengths, including the experimental design, the use of subjective and objective measures of waiting-related frustration, and the relatively large sample recruited from the two cultures. From a practical point of view, the P-DeFT has the potential to be used as a tool to measure preschoolers' ability to regulate behavioral and emotional responses to frustration induced by having to wait, but further validation is needed. The results in the current work highlighted that it is possible for even small changes in waiting duration to bring about significant differences in young children's performance and reactions. The finding that frustration experienced during a delay can spill over to affect subsequent activities after the delay has finished extended the delay aversion concept and provided insight for researchers to explore the aftereffect of waiting-related frustration.

There were also some limitations. First, it is noted that not all the measures in the P-DeFT are significantly correlated with delay sensitivity, and only some measures captured participants' increase of frustration as a function of delay duration. The slight but nonsignificant reduction in press number and activity during delay between 5- and 10-s-delay trials may be due to the fact that children expressed their frustration differently in longer versus shorter delays (i.e., children pressed the button for a longer period of time and showed higher levels of emotional agitation). Future studies can vary the delay duration further, using longer delay intervals, to explore how the different indictors of waiting-related frustration change in magnitude and direction as the length of delay increases. Despite the limitation in the number of delay trials and variation of waiting times in the P-DeFT due to the age of the participants, the behavioral and emotional performance was found to be sensitive to delay duration, supporting its potential usefulness as a short (it lasted 10 min on average), easy to use, and objective measure of delay frustration in preschoolers. Second, in this study, children's delay sensitivity was only rated by parents. Previous research has reported low agreement between parent and teacher ratings of children's behavior, with parents tending to overrate children's problems compared with teachers (Verhulst & Akkerhuis, 1989). It would be valuable to include teachers' report and explore whether the relationship between delay sensitivity and P-DeFT measures also holds for teachers. Third, although we matched for hyperactivity symptoms as rated by parents across cultures, in hindsight it might have also been important to match for objectively measured activity. This is because such ratings appear to be subject to cultural sensitivity thresholds, meaning that the two groups may still differ in their objective levels of activity even when rated by parents as being the same. Fourth, although the instructions were designed to be age appropriate and the preschoolers in this sample showed good understanding of the task, how children actually interpreted the unexpected delay instruction was not explored systematically and we acknowledge that it may have affected performance in this young age group. For future research directions, delay duration can be altered and a longitudinal element can be included to explore how the expressed frustrations during and after a waiting period in early years affect one's socioemotional development years later and whether this will link to psychopathology over time.

Conclusion

Preschool children's frustration expression, during and after the waiting period, varied in its extent systematically as a function of the pre-reward delay duration and individual differences in their delay sensitivity. Post-delay activity may be more sensitive than activity during the delay as a marker of delay aversion.

Data availability

Data will be made available on request.

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Data availability statement

The data that support the findings of this study and other study materials are available on request from the corresponding author (E.S-B.).

Author contributions

W.C.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, visualization, and writing–original draft; K.S.: resources, supervision, and writing–review & editing; J.D.: funding acquisition, methodology, resources, and software; E.S-B.: conceptualization, methodology, resources, supervision, and writing–review & editing.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.jecp.2023.105763.

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