UNDERSTANDING THE AETIOLOGY OF EMOTIONAL OUTBURSTS IN CHILDREN AND YOUNG PEOPLE

By

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ABSTRACT

Children and young people with neurodevelopmental disorders and people who have experienced childhood adversity commonly experience emotional outbursts, which have wide-ranging negative impacts on personal and family wellbeing. Historically, emotional outbursts have been considered as one example of a myriad of challenging behaviours caused by emotion dysregulation, but the specific relationship between such dysregulation and outbursts has received limited attention. The present thesis aimed to establish a transdiagnostic account of the aetiology of emotional outbursts, and to identify measures that might further support the development of this framework. Using a series of mixed-effects models, the capacity to index emotion regulation through performance metrics of a social decision-making game was examined through secondary analysis of data from typically developing children and young people. Furthermore, an informant-report questionnaire (the Emotional Outburst Questionnaire) was developed to transdiagnostically measure the characteristics of emotional outbursts in children and young people. This questionnaire was translated and adapted into a Brazilian-Portuguese version to extend the reach of the measure and to provide a cross-cultural comparison. Data from these two versions of the Emotional Outburst Questionnaire enabled the identification and verification of three distinct patterns of contexts associated with outbursts through cluster analysis. These patterns of contexts were theorised to correspond to different pathways to emotional outbursts, each relating to unique differences in emotion dysregulation. The perspectives of caregivers were analysed through a grounded theory approach to ascertain the aetiological mechanisms involved in each of the proposed pathways, in addition to the general mechanisms of outburst escalation and manifestation. Overall, the present thesis

established an aetiological framework of emotional outbursts that could inform the development of pathway-specific intervention strategies for emotional outbursts.

In memory of Alice Hart.

“While I'm alive, I'll make tiny changes to Earth.”

Scott Hutchison

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CHAPTER 1

GENERAL INTRODUCTION

Definition of emotional outbursts

Within the literature, there is no clear or unified definition of emotional outbursts, but they can be broadly defined as sudden and emotional episodes of challenging behaviour that are disproportionate to the cause (Carlson et al., 2022; Giesbrecht et al., 2010; Potegal & Davidson, 2003). A range of terminology has been used to describe emotional outbursts: “temper tantrums” (or “tantrums”) and ”temper outbursts” have been most commonly used in the literature (e.g., Beauchamp-Châtel et al., 2019; Tunnicliffe et al., 2014); but other terms such as “meltdowns” and “rages” have also been used (e.g., Potegal et al., 2009; Ryan, 2010). The behaviours displayed during outbursts vary considerably across people who experience outbursts, but they have typically been associated with anger (e.g., physical aggression towards others) and distress (e.g., crying; Beauchamp-Châtel et al., 2019; Rice et al., 2018). Similarly, the causes (or antecedents) of emotional outbursts show high degrees of inter- and intraindividual variability, and can include triggering events such as an unexpected change to routine, or a demand to complete a task (Tunnicliffe et al., 2014). There is a general view that emotional outbursts are the developmentally inappropriate manifestation of temper tantrums, which in contrast to emotional outbursts, are considered to be a part of normative development in typically developing toddlers (Belden et al., 2008; Potegal & Davidson, 2003; Wiggins et al., 2018).

Scope and impact of emotional outbursts

Emotional outbursts are one of the most prevalent and developmentally persistent behaviours across people with a wide range of conditions related to altered neurodevelopment, including in people with: intellectual disabilities of varying aetiologies

(e.g., genetic syndromes; Lowe et al., 2007; Myrbakk & Tetzchner, 2008); diagnoses of autism spectrum disorder (Maskey et al., 2013); psychiatric diagnoses (e.g., OCD, ADHD; Krebs et al., 2013; Mayes et al., 2015); and exposure to childhood adversity or trauma (Green et al., 2010). Due to the association between emotional outbursts and neurodevelopmental conditions, a large part of the literature has inevitably focused on outbursts in children and young people.

A range of negative impacts related to emotional outbursts have been identified for people experiencing emotional outbursts and the people around them. As emotional outbursts can commonly involve self-injurious behaviour and aggressive behaviour towards others, there can be an inherent danger to the people experiencing outbursts and those around them (e.g., Potegal et al., 2009; Rice et al., 2018). Episodes of outbursts can be both psychologically and physically taxing for the people experiencing them (Acker et al., 2018), and outbursts can be one of the most stressful behaviours for caregivers to manage (Lowe & Felce, 1995; Montaque et al., 2018; Ryan, 2010).

Aetiology of emotional outbursts

Historically, emotional outbursts have been considered from an operant learning perspective, whereby the occurrence of outbursts or other functionally equivalent challenging behaviours was proposed to be maintained by the positive reinforcement of an association between a behaviour and an establishing operation (e.g., social attention, or demand avoidance; Beavers et al., 2013; Carr & Durand, 1985; Matson et al., 2011). This perspective of functional equivalence is further reflected in common and established measures of behaviour, such as the Child Behavior Checklist (Achenbach & Rescorla, 2001)

and the Developmental Behavior Checklist (Einfeld & Tonge, 1995), in which emotional outbursts are included as a single item within subscales relating to aggressive and disruptive behaviour, respectively. The inclusion of emotional outbursts as an item in such behavioural measures highlights a prevailing dilemma in the conceptualisation of this behaviour: outbursts are often defined as a collection of challenging behaviours (e.g., crying, shouting, physical aggression), yet outbursts are listed alongside these very same behaviours, with each to be considered as a separate phenomenon.

Of the previous studies that have specifically focused on emotional outbursts, most have sought to describe outbursts in terms of observable characteristics (e.g., Beauchamp-Châtel et al., 2019; Cressey et al., 2019; Rice et al., 2018; Tunnicliffe et al., 2014; Wakschlag et al., 2012) and associations with clinical symptoms or psychiatric diagnoses (e.g., Mayes et al., 2015, 2017). Most of these studies have implicitly assumed the central role of emotion dysregulation (consisting of differences in emotion expression and/or regulation; see below for further elaboration) in the manifestation of emotional outbursts, but few have explored this aetiological relationship in detail. Some recent studies have considered the role of emotion dysregulation specifically through between-group comparisons of children who experienced outbursts and children who did not. For example, Roy et al. (2013) demonstrated that children who experienced outbursts expressed fewer positive emotions at the baseline condition of a behavioural task and more negative emotions when frustrated by the difficulty of the task. Furthermore, children who experienced outbursts scored lower on the Emotion Regulation Checklist (Shields & Cicchetti, 1997), a difference which was further associated with a distinct pattern of neural functional connectivity (Roy et al., 2018). However, the value of these findings was precluded by the use of the Emotion Regulation

Checklist, which includes emotional outbursts as an item. This presents a prevailing challenge also associated with other report measures of emotion dysregulation (e.g., the Emotion Dysregulation Inventory; Mazefsky et al., 2018), as they assess observable characteristics of such dysregulation (e.g., outbursts), but they do not directly inform the underlying aetiology of such dysregulation.

Overall, the current literature offers insufficient detail on the aetiological mechanisms of emotional outbursts, which has likely contributed to the lack of effective interventions that target this behaviour (Carlson et al., 2022; Woodcock & Blackwell, 2020a). Given the prevalence and negative impact of outbursts, there is a pressing need for advancing our theoretical understanding of outbursts to inform the development of appropriate interventions. Furthermore, current interventions for emotional outbursts and other challenging behaviours are limited by the lack of focus on individual differences that may necessitate differences in the approaches to intervention (Woodcock & Blackwell, 2020b). Indeed, the consideration of individual differences may be especially informative to outburst aetiology, as: 1) there is large variability in the range of antecedents that can lead to outbursts within and across people (e.g., two people may experience outbursts in response to nonidentical sets of antecedents); and 2) this range of antecedents and setting events reflects a complex collection of processes across social (e.g., disagreement with others), cognitive (e.g., change in routine), sensory (e.g., sudden noise), and physiological (e.g., tiredness) domains, which in combination suggest that there may be a high degree of context-dependent heterogeneity in the relationship between emotion dysregulation and subsequent outbursts (Astle et al., 2022; Cressey et al., 2019; Rice et al., 2018; Tunnicliffe et

al., 2014). Therefore, recognition and delineation of this causal heterogeneity may be critical in developing interventions that can directly target specific mechanisms of outbursts.

Current perspectives on emotion regulation

Exploration of the causal relationship between emotion regulation and outbursts requires a broader understanding of how emotion regulation is conceptualised and how differences in such regulation can give rise to the predicted heterogeneity in the aetiology of outbursts. Whilst there is a wide continuum of perspectives on emotion regulation (Gross & Barrett, 2011), the present section focuses on two predominant and contemporary accounts.

According to the process model of emotion regulation, a person can employ goal-directed regulatory strategies at five different timepoints before or after the initiation of an emotional state (Gross, 2013, 2015). These five points represent distinct families of regulatory processes: 1) situation selection consists of choices that lead towards or away from environments associated with specific emotional states; 2) situation modification involves manipulation of an environment to attain a desired emotional state; 3) attentional deployment encompasses the use of attentional control to alter the emotional state that is initiated; 4) cognitive change involves alterations to how a situation is appraised in terms of its emotional impact; 5) response modulation differs from the other families, as it consists of processes that alter existing emotional states (Gross, 2013, 2015). Overall, emotion regulation as posited by the process model is highly variable and dependent on the context and a person's capacity to access or tendency to use different regulatory strategies (Aldao et al., 2015). Therefore, dysregulation and the subsequent emotional outburst within a given context may be driven by a combination of: 1) the emotional impact of the context (e.g.,

memory of a traumatic event); 2) the person's momentary capacity to access regulatory strategies (e.g., tiredness reducing regulatory resources); and 3) the effectiveness of the regulation, as determined by the strategies employed by the person (e.g., rumination exacerbating the emotional impact of the context) and restricted by the person's repertoire of accessible strategies (e.g., not being able to cognitively reappraise the context).

The psychological constructionist account offers a contrasting perspective, as it proposes that an emotional state (in addition to other mental states such as cognition and perception) is perceived by a person as a consequence of them ascribing meaning to a set of sensory and neurophysiological (conveying valence and arousal) inputs, based on the person's past experiences and learned associations relevant to the given context (Barrett, 2006; Barrett et al., 2013). As such, an emotion regulation strategy can be conceptualised as a context-dependent sequence of domain-general processes (e.g., executive function) that alter how a particular set of sensory and physiological inputs is experienced (Barrett et al., 2013). In relation to dysregulation and emotional outbursts, the factors mentioned above for the process model may similarly apply, but the constructionist account may decompose those factors further into fundamental processes that are also involved in the regulation of other mental states (e.g., a difference in associative learning may lead to ineffective regulation in a given context).

Although these accounts of emotion regulation are sometimes considered to be competing or mutually incompatible, their potential relationship with the aetiology of emotional outbursts can be considered complementary, as both perspectives can account for context-dependent dysregulation associated with outbursts, albeit at different levels of investigation.

Thesis overview

The present thesis consists of four empirical studies that aimed to establish and refine a granular account of the aetiology of emotional outbursts in terms of how emotion dysregulation can lead to outbursts in different contexts, and to develop the appropriate tools to support this endeavour.

The first study involved the secondary analysis of experimental data from a large sample of typically developing children and young people to evaluate the potential for a social decision-making behavioural paradigm to index emotion regulation ability. Additionally, this study assessed the effects of paradigm modifications that might impose greater regulatory demand on children and young people, and the impact of paradigm design on the interpretation of results from such behavioural paradigms.

A novel informant-report questionnaire was introduced in the second study to comprehensively measure the observable characteristics of emotional outbursts in children and young people. This study aimed to identify patterns of contexts from the responses of caregivers that might be aetiologically relevant to outbursts. These patterns were expected to provide the foundation for the exploration of context-dependent mechanisms of emotional outbursts.

The subsequent study involved the translation and adaptation of the questionnaire from English into Brazilian Portuguese, which allowed for additional measure validation and expansion of the questionnaire's potential reach. This study provided an opportunity to examine the patterns of outburst-related contexts in a culturally distinct sample of

caregivers, which enabled verification of the findings from the previous study and development of the theory in a culturally sensitive manner.

In the fourth and final study, caregivers participated in interviews to provide their perspectives on outbursts related to the previously identified patterns of contexts. This study sought to inductively characterise the underlying processes that led to emotion dysregulation and subsequent outbursts within these contexts.

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CHAPTER 2

THE ROLE OF EMOTION REGULATION AND CHOICE REPETITION BIAS IN THE ULTIMATUM GAME

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KAW, RSB, and RK developed the study concept. RK collected the original dataset. JCYC and KAW devised the analytic methodology. JCYC carried out the analysis, data visualisation, and writing of the manuscript. All authors reviewed and edited the manuscript.

The data and computer code used to generate the results are publicly available at https://osf.io/uygpq/.

Abstract

Social decision-making is commonly explored in the context of adult responder behaviour in the Ultimatum Game. Responder behaviour in the game has been proposed to be the consequence of two competing systems that control behaviour: an affective system, which promotes an emotional response to unfair offers; and a deliberative system, which instead encourages a rational response to maximise in-game gains. In a secondary analysis of Ultimatum Game data in children and adolescents (*N* = 429), the present study demonstrated that trial-level metrics of responder behaviour were reflective of a dual systems framework. However, no consistent relationship was found between responder behaviour and trait-level measures of emotion regulation. Choice history was found to influence all measures of responder behaviour in the game. These results support a dual systems account of social decision-making in children and adolescents and highlight choice repetition bias as an additional factor influencing decision-making within the Ultimatum Game.

Introduction

The Ultimatum Game is commonly used to study processes involved in social decision-making (Güth et al., 1982; Güth & Kocher, 2014). The original paradigm involves the interaction between two players: a proposer determines how a monetary sum (stake) should be split between themself and a responder, who in turn chooses whether to accept or reject this offer. Acceptance of the offer results in both parties gaining their split of the stake according to the offer of the proposer, whereas rejection of the offer results in no gain for either party.

In the face of offers that are unfavourable (unfair) to the responder, the "rational" choice for the responder would be to accept these offers in order to maximise their gains within the game. However, studies of responder behaviour in the game have consistently reported an increased likelihood of rejecting unfair offers (e.g., Sanfey et al., 2003). Multiple frameworks have been proposed to explain this pattern of responder behaviour (for reviews, see Hallsson et al., 2018; Zheng et al., 2017). Whilst a large number of processes contribute to decision-making in the Ultimatum Game (for a review of contemporary theories of social decision-making, see Murray et al., 2021), the scope of the present study focuses on one such account: the *dual-process theory*, which describes an affective (emotional) system and a deliberative (rational) system that operate in parallel and compete to determine the decision of the responder (Alós-Ferrer & Strack, 2014; Loewenstein & O'Donoghue, 2004; Sanfey & Chang, 2008; but see Pfeifer & Allen, 2012, 2016 for critiques on the dual-process theory). In the context of decision-making, the affective system is considered to be fast, automatic, and responsible for immediate reactions; whereas the deliberative system is

slower, demands effortful control, and has the potential to modulate the affective response (Sanfey & Chang, 2008). According to this framework, an unfair offer presents conflict between the two systems, as a responder may reject the offer as an immediate, emotional response, whereas the responder may accept the unfair offer if they are able to successfully regulate their emotions through the top-down control via the deliberative system, which would necessitate a longer response time (Alós-Ferrer & Strack, 2014; Sanfey & Chang, 2008). The ability to regulate one's emotions can be considered both as a trait, which represents a stable pattern of regulation tendencies; and as momentary states, which are variable and context-dependent (Colombo et al., 2020; McMahon & Naragon-Gainey, 2020).

The involvement of an emotional component in response to unfair offers in the Ultimatum Game has been demonstrated in prior research, as unfair offers can evoke anger, sadness, and contempt in adult responders (Gilam et al., 2019; Kravitz & Gunto, 1992; Pillutla & Murnighan, 1996; Tabibnia et al., 2008). The feeling of anger in adult responders could be accentuated by comments supposedly made by the proposer that emphasised the inequity of the offer, consequently decreasing the acceptance rate of unfair offers (Kravitz & Gunto, 1992). However, when comments were designed to specifically elicit anger in adult responders using threats and insults, the acceptance rate of unfair offers and the feeling towards offers were not affected, suggesting that perhaps the emphasis on inequity was important in altering responder behaviour (Gilam et al., 2019).

Studies involving manipulations of the ability for a responder to regulate their emotions further support the role of top-down control in decision-making within the Ultimatum Game. For example, the acceptance rate of unfair offers increased when adult responders were

instructed to employ the emotion regulation strategy of reappraisal to interpret unfair offers as less negative (Grecucci et al., 2013, 2020; van 't Wout et al., 2010). On the other hand, inducing sadness in adult responders prior to the game decreased the acceptance rate of unfair offers (Harlé & Sanfey, 2007). Consistent with the different temporal characteristics of the two systems proposed by the dual-process theory, adult responders rejected unfair offers more quickly and accepted unfair offers more slowly when compared to evenly split (fair) offers (Lin et al., 2020).

In conjunction with the two systems, the history of past decisions may further influence responder behaviour in the Ultimatum Game. Indeed, in the wider literature of perceptual and value-based decision-making, there is a robust tendency for individuals to repeat their recent choices (Akaishi et al., 2014; Alós-Ferrer et al., 2016; Bosch et al., 2020; Senftleben et al., 2019). In social decision-making paradigms involving repeated interactions with the same partner, studies have mainly explored the influence of previous actions of the partner on the subsequent actions of a player (e.g., Alós-Ferrer & Farolfi, 2019; Hilbe et al., 2018). The effect of one's past decisions on one's subsequent decision-making has received less attention, but studies with variants of the Prisoner's Dilemma, in which players were required to reciprocally cooperate to maximise overall gains, found that players had the tendency to repeat their previous decisions to cooperate, which was further influenced by the actions of their partners (Blake et al., 2015; Grujic et al., 2010; Grujić & Lenaerts, 2020).

In the context of the Ultimatum Game, the behaviour of the proposer has been found to be influenced by whether their previous offer was accepted or rejected (Achtziger et al., 2016, 2018). However, it remains unclear whether the decision history of a responder has bearing

on their own subsequent choices. Whilst it is conceivable that across repeated rounds of the Ultimatum Game, past decisions of the responder may affect their subsequent decision-making with the same proposer, the extent to which past decisions could similarly influence responder behaviour in encounters with new proposers is unknown. If past decisions are indeed influential in the decision-making of subsequent interactions with new partners, this may necessitate a shift in how data from "one-shot" paradigms should be analysed and interpreted, as each round of interaction is typically regarded as independent from the outcome of the previous round (e.g., van 't Wout & Sanfey, 2008).

As much of the research on the Ultimatum Game has focused on the behaviour of adults, the literature on responder behaviour in children and adolescents has been less comprehensive. Developmental evidence suggests that the affective and deliberative systems follow different developmental trajectories over childhood and adolescence, with the affective system being favoured especially during adolescence (e.g., Shulman et al., 2016). However, it is currently unclear whether these developmental differences may influence the decision-making of children and adolescents in the Ultimatum Game to produce differing patterns of behaviour compared to adult responders. Consistent with the literature on adult responder behaviour, unfair offers were more likely to be rejected by children and adolescents compared to fair offers (Sally & Hill, 2006; Steinbeis et al., 2012; Sutter, 2007). However, the affective system appeared to be more dominant in influencing the responder behaviour of children and adolescents, as they were more likely to reject unfair offers compared to adult responders (Murnighan & Saxon, 1998; Sutter, 2007). Critically, there is a lack of research on the other metrics of responder behaviour in children and adolescents, in terms of the temporal dynamics of offer acceptance and rejection and the emotions elicited by unfair

offers. Investigation into these aspects of responder behaviour in children and adolescents could provide further insight as to whether the dual-process theory might be applicable for children and adolescents as it appears to be for adults, or whether there might be developmental differences that could alter such an account.

This study investigated how the responder behaviour of children and adolescents in the Ultimatum Game might be affected at a trial-level by the following: 1) the addition of proposer comments; 2) trait emotion regulation; and 3) the decision history of the responder. It was hypothesised that negative comments displayed in conjunction with unfair offers might provoke a heightened emotional response, which would be reflected by a lower acceptance rate, longer response time to accept, and the experience of more negative emotions. With regards to unfair offers in general, it was expected that trait-level emotion regulation in children and adolescents would influence the relationship between momentary emotional states and decision-making, such that greater trait emotion regulation would predict increased acceptance rate, decreased response time to accept, and decreased experience of negative emotions. Previous decisions were expected to affect subsequent decisions in response to unfair offers in children and adolescents but given that this factor had rarely been considered in previous social decision-making research, no specific pattern of results was hypothesised.

Methods

This study involved the secondary analysis of data collected as part of an unpublished postgraduate dissertation (Shields, 2015). Participant informed assent and parental informed consent were obtained for individuals taking part in the original study, which was approved

by the School of Psychology Research Ethics Committee at Queen's University Belfast. A subset of the data was previously used as age-matched controls in a study assessing social decision-making in autistic adolescents (Woodcock et al., 2020).

Participants

Overall, 482 children and adolescents were recruited through convenience sampling from classes within primary and secondary schools in Northern Ireland and the Republic of Ireland. Sample availability in the original study was pragmatically constrained by the number of schools able to take part in the research, and by the class sizes within those schools. Data regarding gender and Ultimatum Game performance were missing for 24 children and adolescents, who were consequently excluded from analysis. Further exclusions were applied based on responder behaviour in the Ultimatum Game (see below), such that the final analysis involved 429 participants. The final sample consisted of 201 males (46.9%) and 228 females (53.1%), with a mean age of 10.5 years (standard deviation = 3.1; range = 6–17).

Measures

Ultimatum Game

The details of the computerised Ultimatum Game paradigm have previously been reported in a separate article (Woodcock et al., 2020). In brief, participants were presented with offers perceived to be proposed by another player, when in fact these offers were predetermined by the researchers. Each offer involved a monetary sum being divided either fairly or unfairly, with 20% of the monetary value being offered to the participant. Participants responded by pressing one of two keys on the keyboard to accept or reject each

offer. The response mappings between the keys and the decisions were counterbalanced across participants. Following their decision, participants were asked to rate the degree of negative valence associated with the offer on a 5-point Likert-like scale (1 – *Completely calm and relaxed* to 5 – *Very annoyed*). The task utilised visual stimuli and pre-recorded verbal instructions throughout. Participants completed a total of 36 trials divided into two blocks. Each trial involved a different proposer that the participant had not yet encountered. Twelve of the trials involved fair offers, whilst the remaining 24 trials involved unfair offers.

Three versions of the computerised paradigm with different modifications were used (Supplementary Table S2.1). In the original study, these modifications were intended to impose regulatory demands on participants to evaluate the use of the Ultimatum Game as an index of emotion regulation. In the Two-stakes paradigm, offers involved one of two stake sizes (£100 and £1). In the Four-stakes paradigm, four possible stake sizes (£100, £10, £1, £0.10) were included to maintain engagement to the task for older participants. The Comments paradigm utilised two stake sizes (£100 and £1) and the addition of a comment when the proposer was introduced. In 18 of the unfair trials, the comments were associated with negative intent (e.g., 'Did you really expect half?') and the remainder of unfair trials and all fair trials included neutral comments (e.g., 'Here is my offer…'). There were more negative comments than neutral comments in the unfair trials as the negative comments were assumed to evoke greater regulatory demands. The comments were unique across trials (Supplementary Table S2.1). A range of stake sizes were included in all three paradigms as a pragmatic consideration to increase the potential sensitivity of the paradigms in capturing emotion regulation in responders who may be more inclined to reject unfair offers

(e.g., due to impaired emotion regulation), as higher monetary values may incentivise acceptance of unfair offers (Tabibnia et al., 2008; Van Der Veen & Sahibdin, 2011).

Children's Emotion Management Scales

The Children's Emotion Management Scales (CEMS) comprise of 33 items distributed across three scales pertaining to children's general ability to regulate feelings of anger, sadness, and anxiety (Zeman et al., 2001, 2002, 2010). Each item is scored on a 3-point Likert scale (1 – *Hardly ever;* 2 – *Sometimes*; 3 – *Often*). Each of the emotion management scales is further divided into subscales of Inhibition, Coping, and Dysregulation related to the corresponding emotion. The scales demonstrated acceptable to good internal consistency and test-retest reliability (Zeman et al., 2001, 2002, 2010). The CEMS were administered on the computer with verbal instructions and visual aids to indicate possible response options. A trait measure of emotion regulation was used, as it was expected to provide an indication of how responders might regulate their emotional states within the Ultimatum Game. Eight participants in the final sample had missing CEMS data.

Procedure

Participants were informed of potential prizes based on performance in the Ultimatum Game. Prior to the game, participants completed a computerised version of the CEMS. To simulate the social component of the Ultimatum Game, participants entered their name and the name of a preferred cartoon character. Participants were assigned to one of the three paradigms. Children and adolescents first acted as the proposer and decided whether they would propose fair or unfair offers. Individuals in the Comments paradigm were required to input a comment that accompanied their proposed offer. The data related to the offers

proposed by participants have not been included in the present analysis. Participants completed a practice session as the responder, followed by two further sessions. Participants were led to believe that each offer in these two sessions were selected from offers made by previous participants from the study. Upon completion of the study, participants were informed of the harmless deception involved, which had been approved by the School of Psychology Research Ethics Committee at Queen's University Belfast, and 10% of participants were randomly selected to receive £5 in Amazon vouchers as their prize.

Prior to analysis, additional exclusion criteria were applied to the data to ensure that participants sufficiently understood and attended to the game. Seventeen participants were excluded if they accepted <66% of fair offers associated with the larger stake sizes (£100 in Two-stakes and Comments; £100 and £10 in Four-stakes), or if they accepted <66% of all fair offers regardless of stake size, as these conditions indicated insufficient understanding of the game. Trials with response time (RT) < 0.5 seconds or RT > upper quartile + 2 * interquartile range were excluded as outliers[1]. Twelve participants were excluded as more than half of their trials were removed based on RT. The characteristics of the participants retained after exclusion are presented in Table 2.1.

[1] This criterion was used in a previous study that analysed a subset of the same data (Woodcock et al., 2020). A rerun of the analysis with the commonly used criterion of RT > Q3 + 1.5*IQR found no changes to significance in the main findings, apart from the interaction effect of fairness and decision on RT in the two between-paradigm comparisons decreasing in level of significance from $p < 0.05$ to $p \geq 0.05$.

Table 2.1 Characteristics of participants assigned to each Ultimatum Game paradigm.

Variable	Paradigm		
	Two-stakes	Four-Stakes	Comments
Age (*n*)			
6	8	-	11
7	22	-	27
8	22	19	33
9	-	46	26
10	-	17	30
11	-	6	10
12	-	25	-
13	-	23	-
14	-	27	-
15	-	35	-
16	-	38	-
17	-	4	-
Total	52	240	137
Mean	7.3	12.4	8.5
SD	0.7	2.8	1.4
Range	6–8	8–17	6–11
Gender (%)			
Male	48.1	44.2	51.1
Female	51.9	55.8	48.9

Statistical Analyses

The data were analysed at the trial-level using a series of generalised linear mixed-effects models with random individual and trial intercepts, using the lme4 package (Bates et al., 2015) in R 4.0.2 (R Core Team, 2021). General recommendations for mixed-effects models suggest a minimum number of 10-40 trials per participant, so this type of analysis is appropriate for the present data (Bolker et al., 2009; Brysbaert & Stevens, 2018). Each set of analyses involved three separate univariate models, each with a different response variable corresponding to responder behaviour characteristics that were of interest: decision, RT, and

negative valence rating. Logistic mixed-effects models were used to analyse decision, with the significance of coefficients evaluated using Wald z-tests. Linear mixed-effects models were used for RT and negative valence rating, with the significance of coefficients evaluated using t-tests with Satterthwaite's approximation implemented in the lmerTest package (Kuznetsova et al., 2017). RTs in seconds were log-transformed and continuous predictor variables were centred around the means within each paradigm. Stake size was coded as a categorical variable with the stakes arranged in descending order. The effect sizes of main effects and interaction terms are reported in terms of unstandardised *b* coefficient estimates and 95% confidence intervals (CIs). To aid interpretation, significant main effects and interaction terms are further elaborated in terms of estimates of percent change in odds, percent change in RT, and change in arbitrary units for negative valence rating, as derived from the unstandardised *b* coefficients.

Direct comparisons between paradigms were carried out to explore the potential effects of paradigm modifications. These comparisons used subsets of participants of overlapping or similar age to limit the confounding potential of age. To investigate the effect of varying the number of stake sizes, responder behaviour was compared between 7- and 8-year-olds from the Two-stakes paradigm and 8- and 9-year-olds from the Four-stakes paradigm (*n* = 44 and 65, respectively; total number of trials = 3,604). The effect of the presence of comments was analysed by comparing data from 6- to 8-year-olds from the Two-stakes and Comments paradigms (*n* = 52 and 71, respectively; total number of trials = 4,008). Each model in both sets of comparisons included main effects of gender, fairness, paradigm, and the interaction between fairness and paradigm. Models with RT or negative valence rating as the response variable additionally included decision of the current trial as a main effect and the two- and

three-way interactions between decision, fairness, and paradigm. For the comparisons between Two-stakes and Four-stakes, age was included as a main effect to account for the different age ranges of the two subsets.

The effects of trait emotion regulation and decision history on responder behaviour were subsequently analysed within each paradigm, as there were methodological differences between the paradigms that precluded aggregation of the data. Trials from children that were analysed in the between-paradigm comparisons were included in this set of analyses. Separate models were estimated for each paradigm, to identify consistent effects that were robust to differences in paradigm and sample characteristics. As unfair offers were of particular interest in relation to emotion regulation and decision history, trials involving fair offers were excluded from these analyses (total number of unfair trials in Two-stakes = 1,051; Four-stakes = 5,454; Comments = 3,100). These models included main effects of age, gender, decision from previous trial, stake size, and the nine subscales of the CEMS. Models with RT or negative valence rating as the response variable additionally included decision of the current trial as a main effect and the two-way interactions between decision of the current trial and: age, decision from previous trial, and stake size. Models for the Comments paradigm additionally included the main effect of nature of the comment (neutral or negative) and the interaction between decision of the current trial and the nature of the comment.

Transparency and Openness

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. The data and computer code used to generate the results are

publicly available at https://osf.io/uygpq/ (Chung et al., 2021). Data were processed and analysed in R 4.0.2 (R Core Team, 2021) with the packages dplyr (Wickham et al., 2020), lme4 (Bates et al., 2015) and lmerTest (Kuznetsova et al., 2017); and visualised with the packages ggplot2 (Wickham, 2016), ggsignif (Ahlmann-Eltze, 2019), and patchwork (Pedersen, 2020). This study's design and its analysis were not pre-registered.

Results

Effect of Modifications on Responder Behaviour

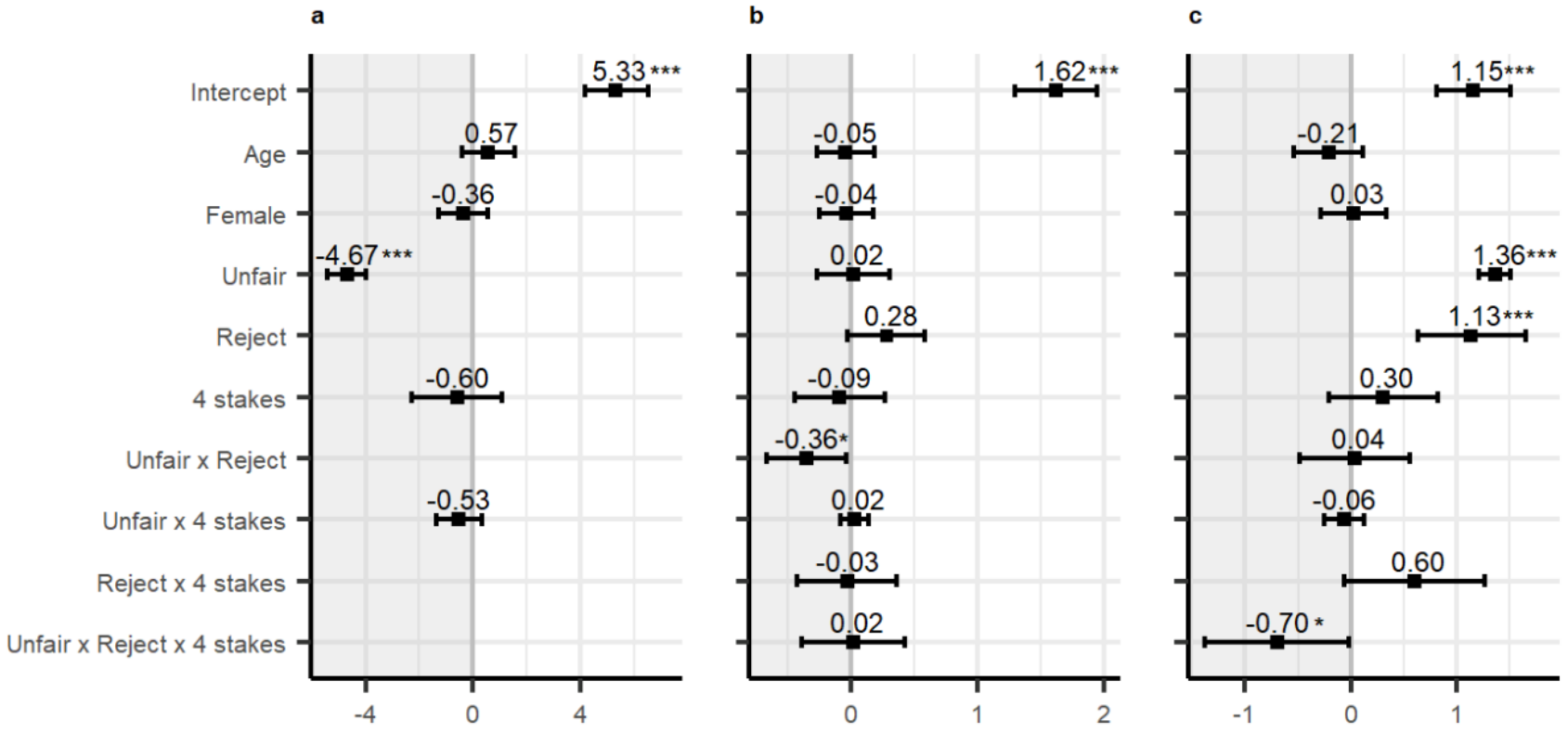
Number of Stake Sizes

The comparison between subsets of data from the Two-stakes and Four-stakes paradigms are presented in Figure 2.1. The main effect of fairness was significant (z = -12.893, p < 0.001), such that compared to fair trials, unfair trials reduced odds of acceptance by 99.1% and 99.4% in the Two-stakes and Four-stakes paradigms, respectively. There was a significant interaction between fairness and decision on RT (t = -2.219, p = 0.027), such that compared to fair offers, RT increased when accepting unfair offers (Two-stakes: +1.5%; Four-stakes: +3.9%) and decreased when rejecting unfair offers (Two-stakes: -29.0%; Four-stakes: -26.0%). In terms of negative valence rating, there were significant main effects of fairness (t = 17.940, p < 0.001) and decision (t = 4.373, p < 0.001). Furthermore, there was a significant interaction between fairness, decision, and paradigm on negative valence rating (t = -2.004, p = 0.045). Overall, negative valence rating increased in unfair compared to fair trials (Two-stakes accept (change in rating points): +1.36; Two-stakes reject: +1.39; Four-stakes accept: +1.30; Four-stakes reject: +0.63) and in rejected compared to accepted trials (Two-stakes fair (change in rating points): +1.13; Two-stakes unfair: +1.17; Four-stakes fair: +1.73; Four-

stakes unfair: +1.07). The significant interaction appeared to have been driven by the larger increase in negative valence rating when rejecting fair offers in the four-stakes paradigm.

There was no other significant main effect or interaction involving the number of stake sizes.

Figure 2.1 Fixed effect unstandardised coefficients from mixed-effects models with 7- and 8-year-olds from the Two-stakes paradigm and 8- and 9-year-olds from the Four-stakes paradigm. (**a**) Coefficients from the model predicting changes in log odds of an offer being accepted over being rejected by a responder. A positive value indicates an increase in the odds of an offer being accepted, whilst a negative value (in shaded area) indicates a decrease in the odds of an offer being accepted. (**b**) Coefficients from the model predicting changes in log-transformed response time. A positive value indicates an increase in response time, whilst a negative value (in shaded area) indicates a decrease in response time. (**c**) Coefficients from the model predicting changes in negative valence rating. A positive value indicates an increase in negative valence, whilst a negative value (in shaded area) indicates a decrease in negative valence.



Error bars represent 95% CIs of *b* coefficient estimates.

* $p < 0.05$, *** $p < 0.001$.

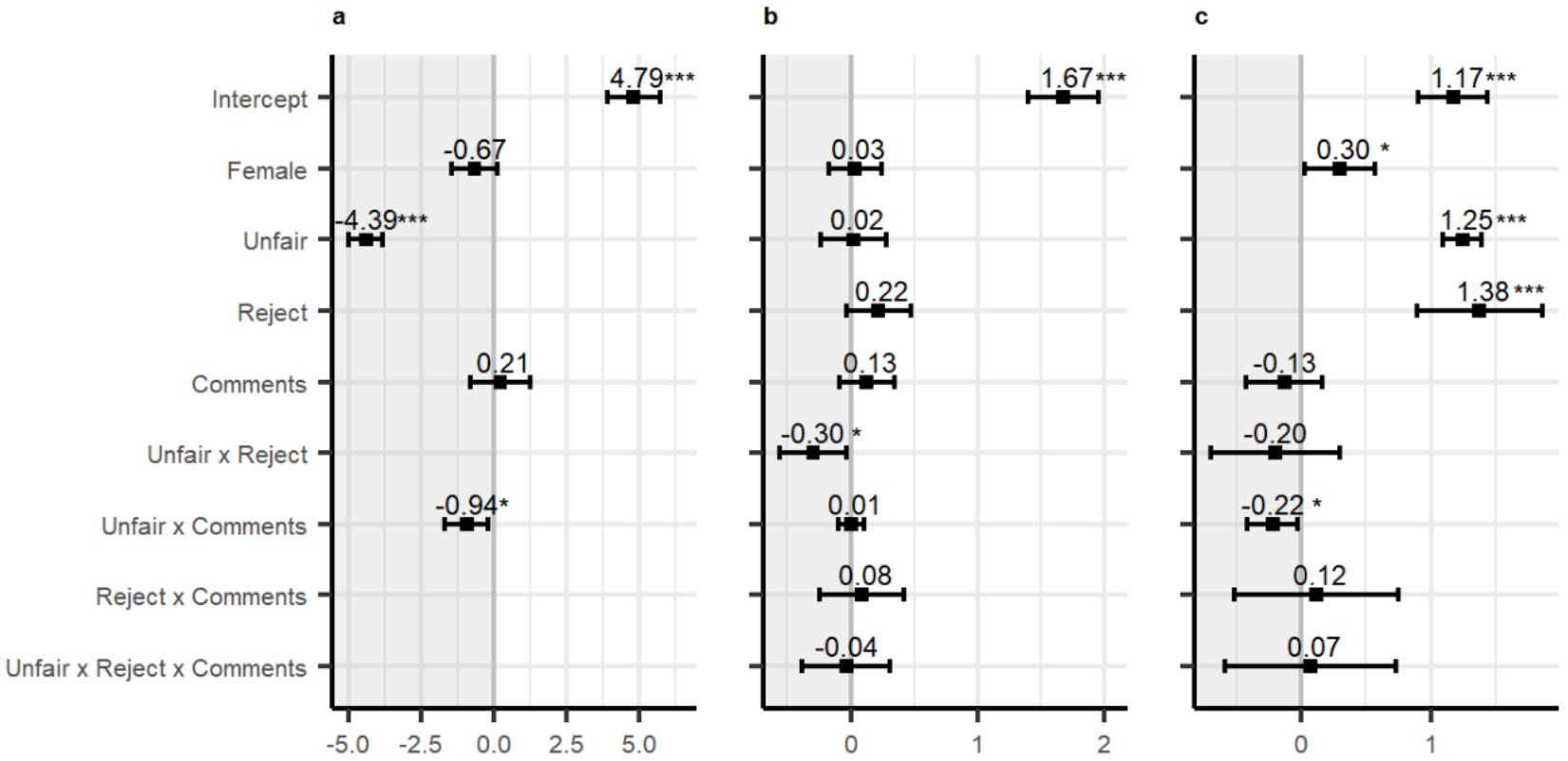
Presence of Comments

The models of the comparison between individuals of the same age from the Two-stakes and Comments paradigms are presented in Figure 2.2. There was a significant main effect of gender on negative valence rating, such that female participants from this subset comparison reported greater negative valence (+0.30, t = 2.145, p = 0.034). The effects of the game were generally consistent with the findings from the comparison between the Two-stakes and Four-stakes paradigms. There was a significant main effect of fairness (z = -14.715, p < 0.001) and a significant interaction between fairness and the presence of comments on decision (z = -2.481, p = 0.013), such that the odds of acceptance decreased for unfair offers by 98.8% for the Two-stakes paradigm, compared to 99.5% for the Comments paradigm. The interaction between fairness and decision on RT was significant (t = -2.203, p = 0.028), as unfair offers increased RT to accept (Two-stakes: +2.1%; Comments: +2.8%) and decreased RT to reject (Two-stakes: -24.1%; Comments: -26.3%) compared to fair offers. In terms of effects on negative valence rating, the main effects of fairness (t = 16.358, p < 0.001) and decision were significant (t = 5.616, p < 0.001), and there was a significant interaction between fairness and the presence of comments (t = -2.222, p = 0.026). Consistent with the comparison between the Two-stakes and Four-stakes paradigms, negative valence rating increased when offers were unfair compared to when offers were fair (Two-stakes accept (change in rating points): +1.25; Two-stakes reject: +1.05; Comments accept: +1.03; Comments reject: +0.90) and when offers were rejected compared to being accepted (Two-stakes fair (change in rating points): +1.38; Two-stakes unfair: +1.18; Comments fair: +1.49; Comments unfair: +1.37). The interaction between fairness and the

presence of comments appeared to stem from the larger increase in negative valence rating for unfair offers in the Two-stakes paradigm.

There was no other significant main effect or interaction involving the addition of comments in the game.

Figure 2.2 Fixed effect unstandardised coefficients from mixed-effects models with 6- to 8-year-olds from the Two-stakes and Comments paradigms. (**a**) Coefficients from the model predicting changes in log odds of an offer being accepted over being rejected by a responder. A positive value indicates an increase in the odds of an offer being accepted, whilst a negative value (in shaded area) indicates a decrease in the odds of an offer being accepted. (**b**) Coefficients from the model predicting changes in log-transformed response time. A positive value indicates an increase in response time, whilst a negative value (in shaded area) indicates a decrease in response time. (**c**) Coefficients from the model predicting changes in negative valence rating. A positive value indicates an increase in negative valence, whilst a negative value (in shaded area) indicates a decrease in negative valence.



Error bars represent 95% CIs of *b* coefficient estimates.

* $p < 0.05$, *** $p < 0.001$.

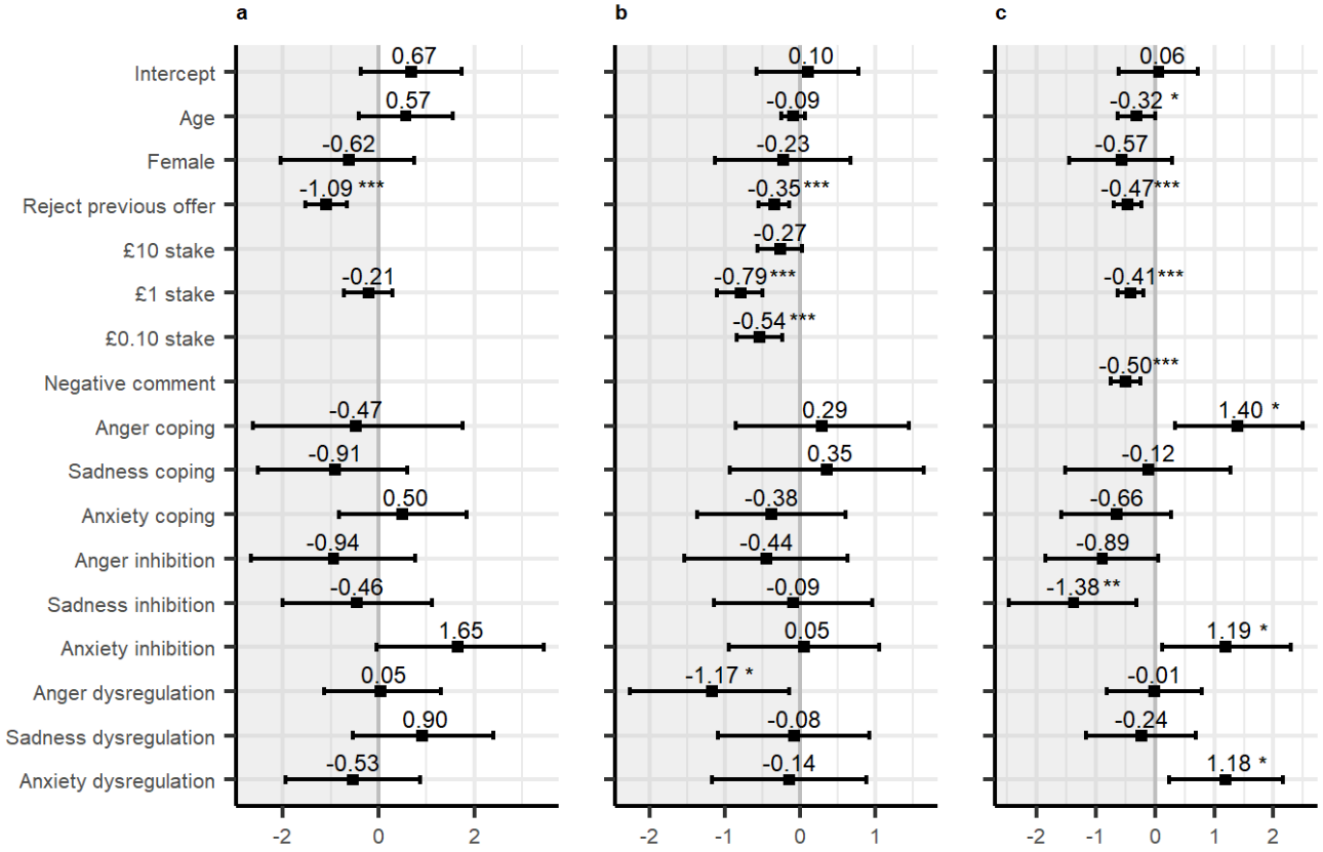
Effect of Emotion Regulation and Decision History on Responder Behaviour in Unfair Trials

Decision

The models of decision for unfair trials in each paradigm are presented in Figure 2.3. The odds of accepting an unfair offer in 6- to 11-year-olds decreased by 27.3% for every increase in 1 year of age in the Comments paradigm (z = -1.992, p = 0.046). Compared to offers with £100 stake, smaller stakes decreased the odds of accepting unfair offers in the Four-stakes (£1: -54.8%, z = -5.517, p < 0.001; £0.10: -41.5%, z = -3.810, p < 0.001) and Comments paradigms (£1: -33.9%, z = -3.893, p < 0.001). Similarly, compared to neutral comments, the presence of negative comments decreased the odds of accepting unfair offers by 39.5% in the Comments paradigm (z = -4.067, p < 0.001).

In terms of trait emotion regulation as measured by the CEMS, there were several significant main effects of different CEMS subscales on decision across the three models, but no effect was consistently significant across the paradigms. By contrast, the main effect of decision from the previous trial was significant across all three paradigms, as rejection of the previous trial consistently predicted reduced odds of accepting the unfair offer of the current trial (Two-stakes: -66.4%, z = -4.934; Four-stakes: -29.3%, z = -3.502; Comments: -37.2%, z = -3.890, all p < 0.001).

Figure 2.3 Fixed effect unstandardised coefficients from logistic mixed-effects models in the (**a**) Two-stakes, (**b**) Four-stakes, and (**c**) Comments paradigms. Coefficients in all three models predict changes in log odds of an offer being accepted over being rejected by a responder. A positive value indicates an increase in the odds of an offer being accepted, whilst a negative value (in shaded area) indicates a decrease in the odds of an offer being accepted.



Error bars represent 95% CIs of *b* coefficient estimates.

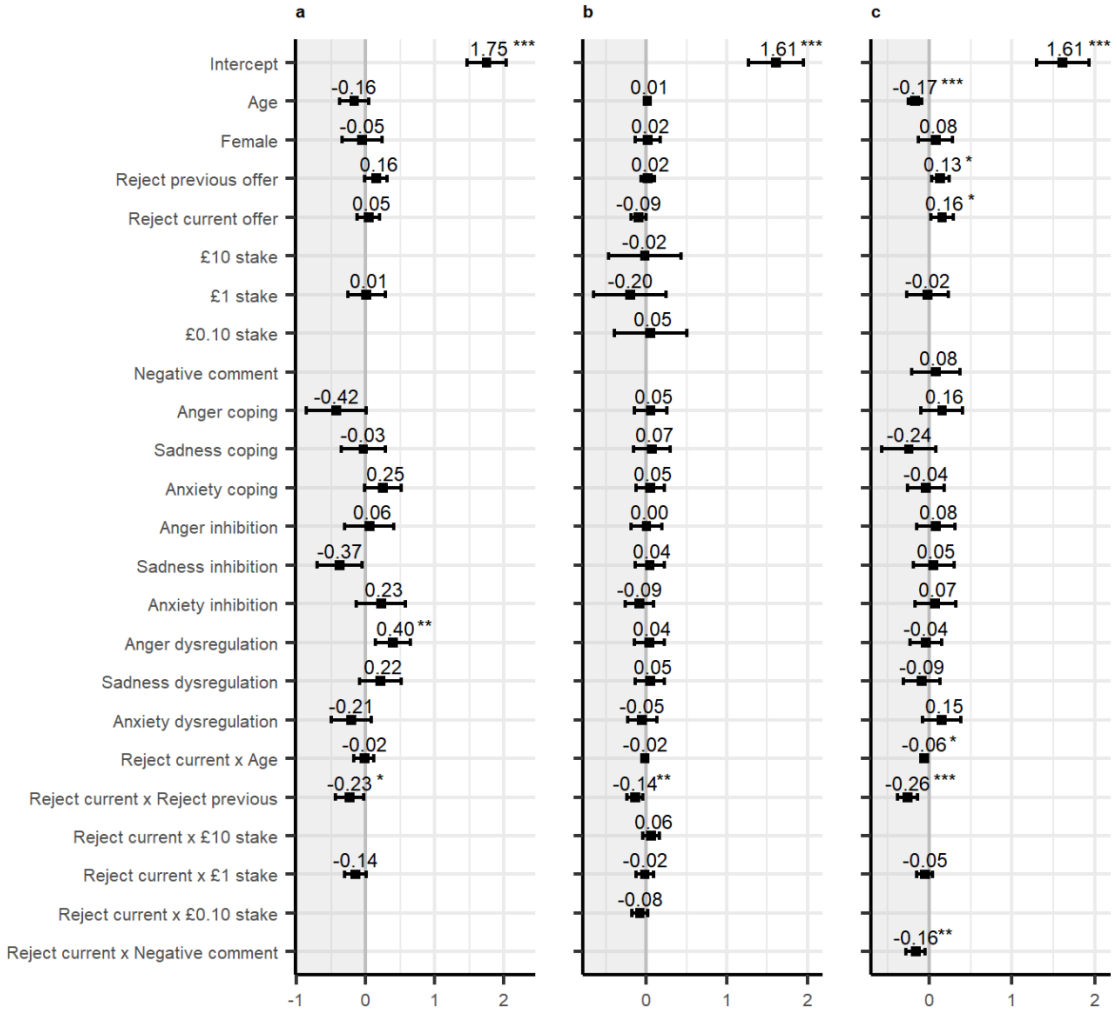
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Response Time

The models of RT for unfair trials in each paradigm are presented in Figure 2.4. In the Comments paradigm, there was a significant main effect of age (t = -4.010, p < 0.001) and an interaction effect between age and decision (t = -2.575, p = 0.010), such that for every increase of 1 year from the mean age, RT decreased by 15.8% and 20.6% in 6- to 11-year-olds when accepting and rejecting offers, respectively. The interaction between decision and the nature of the comment in unfair trials of the Comments paradigm was significant (t = -2.809, p = 0.005), as unfair offers with negative comments increased RT to accept by 8.6% and decreased RT to reject by 7.6% compared to unfair offers with neutral comments.

The effects of trait emotion regulation on RT were similar to the effects reported on decision, as several different CEMS subscales were significant, but there was no consistent effect across the paradigms. In the Comments paradigm, the main effects of decisions from the previous (t = 2.478, p = 0.013) and current trial were significant (t = 2.271, p = 0.023). A consistent interaction between previous and current decisions was observed across all three paradigms (Two-stakes: t = -2.227, p = 0.026; Four-stakes: t = -2.745, p = 0.006; Comments: t = -4.115, p < 0.001). Rejection as opposed to acceptance of the previous offer polarised the RT of the current unfair trial, such that the time taken to accept the current offer was increased (Two-stakes: +16.9%; Four-stakes: +2.2%; Comments: +14.3%) and the time taken to reject the current offer was decreased across all three paradigms (Two-stakes: -7.3%; Four-stakes: -11.0%; Comments: -11.8%).

Figure 2.4 Fixed effect unstandardised coefficients from linear mixed-effects models in in the (**a**) Two-stakes, (**b**) Four-stakes, and (**c**) Comments paradigms. Coefficients in all three models predict changes in log-transformed response time. A positive value indicates an increase in response time, whilst a negative value (in shaded area) indicates a decrease in response time.



Error bars represent 95% CIs of *b* coefficient estimates.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

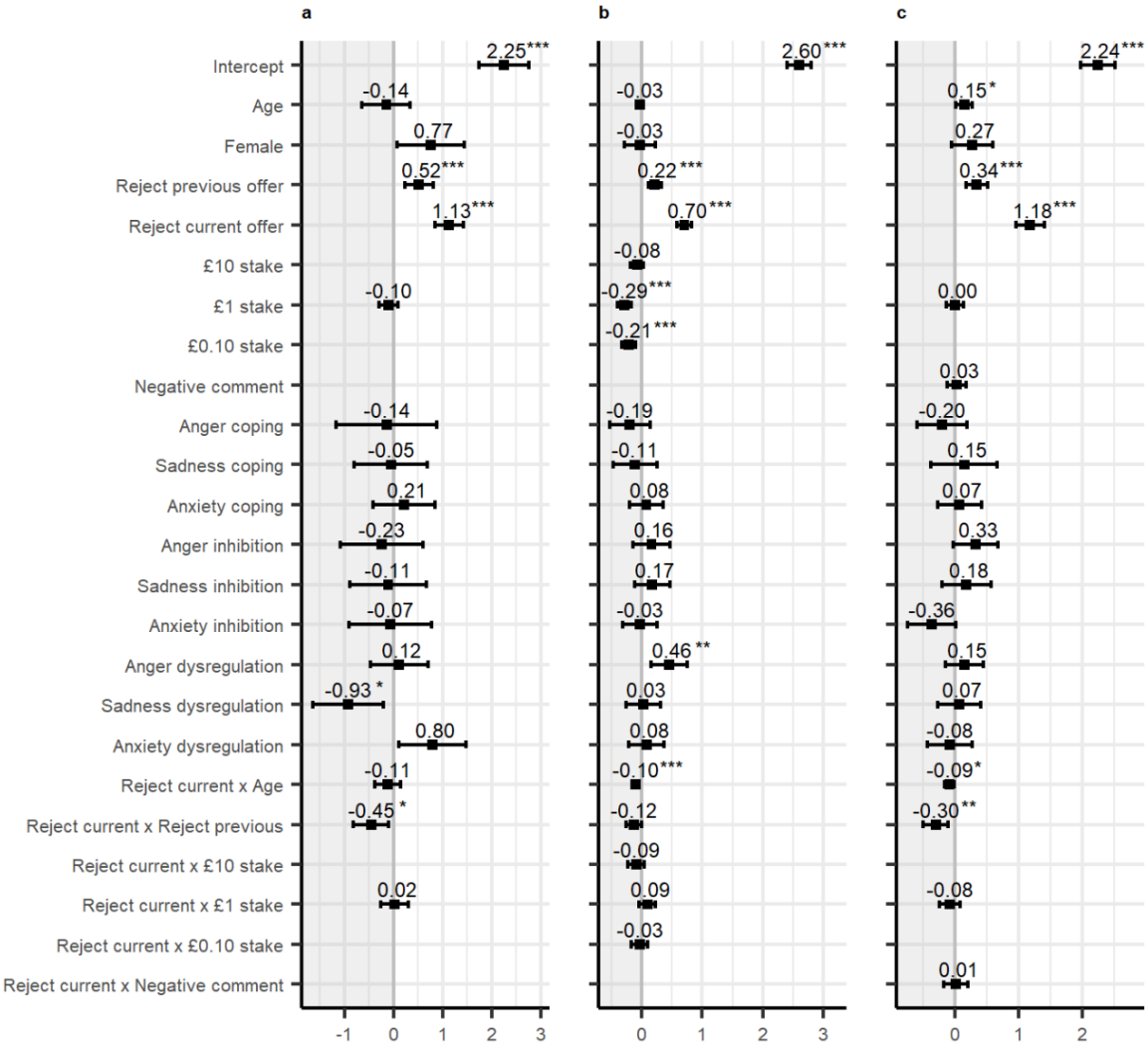
Negative Valence Rating

The models of negative valence rating for unfair trials in each paradigm are presented in Figure 2.5. There was a significant main effect of age in the Comments paradigm (t = 2.158, p = 0.032). The interaction between age and decision was significant in the Four-stakes (t = -8.020, p < 0.001) and Comments paradigms (t = -2.282, p = 0.023), such that for every increase of 1 year from the mean age, negative valence rating in the Four-stakes paradigm decreased by 0.03 rating points when offers were accepted and negative valence rating decreased by 0.13 when offers were rejected by 8- to 17-year-olds; conversely, negative valence rating of 6- to 11-year-olds from the Comments paradigm increased by 0.15 and 0.06 for every increase of 1 year from the mean age when offers were accepted and rejected, respectively. Unfair offers of smaller stakes in the Four-stakes paradigm elicited lower levels of negative valence compared to offers with £100 stake (£1: t = -4.778, p < 0.001; £0.10: t = -3.646, p < 0.001) when accepting (£1 (change in rating points): -0.29; £0.10: -0.21) and rejecting offers (£1 (change in rating points): -0.19; £0.10: -0.25). There was no significant main effect or interaction involving the nature of comments in the Comments paradigm.

As with the effects of trait emotion regulation on decision and RT, no effect of any CEMS subscale was consistently observed across paradigms. Across all three paradigms, the main effects of decisions from the current (Two-stakes: t = 7.771; Four-stakes: t = 11.202; Comments: t = 10.447, all p < 0.001) and previous trials were significant (Two-stakes: t = 3.573; Four-stakes: t = 3.949; Comments: t = 3.974, all p < 0.001). The interaction between previous and current decisions was significant in the Two-stakes (t = -2.466, p = 0.014) and

Comments paradigms (t = -2.931, p = 0.003). Overall, rejection as opposed to acceptance of the current offer increased negative valence rating regardless of whether the previous offer was accepted (Two-stakes (change in rating points): +1.13; Four-stakes: +0.70; Comments: +1.18) or rejected (Two-stakes (change in rating points): +0.68; Four-stakes: +0.58; Comments: +0.88). Furthermore, rejection as opposed to acceptance of the previous offer increased negative valence rating when the current offer was accepted (Two-stakes (change in rating points): +0.52; Four-stakes: +0.22; Comments: +0.34) or rejected (Two-stakes (change in rating points): +0.07; Four-stakes: +0.09; Comments: +0.04).

Figure 2.5 Fixed effect unstandardised coefficients from linear mixed-effects models of in **a**) Two-stakes, (**b**) Four-stakes, and (**c**) Comments paradigms. Coefficients in all three models predict changes in negative valence rating. A positive value indicates an increase in negative valence, whilst a negative value (in shaded area) indicates a decrease in negative valence.



Error bars represent 95% CIs of *b* coefficient estimates.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Summary of Main Findings

When children of similar ages were compared between paradigms, consistent effects involving the fairness of trials were found across comparisons. Compared to fair trials, unfair trials were less likely to be accepted; were rejected more quickly and accepted more slowly; and were associated with increased negative valence rating.

Analysis of the unfair trials within each paradigm revealed that previous rejection consistently influenced subsequent decision-making: the odds of acceptance decreased; the RT for acceptance increased whilst the RT for rejection decreased; and negative valence rating increased.

In terms of modifications to the Ultimatum Game, negative responder comments decreased both the odds of offer acceptance and the RT for rejection, whilst the RT for acceptance increased. Unfair offers involving smaller stakes decreased the odds of acceptance in the Four-stakes and Comments paradigms and elicited lower negative valence rating in the Four-stakes paradigm.

Lastly, no effect of trait emotion regulation as measured by the CEMS was found to be consistently significant across paradigms or across metrics of responder behaviour.

Discussion

This article examined the responder behaviour of children and adolescents in the Ultimatum Game at the trial level within the context of the dual-process theory to specifically explore how paradigm modifications, trait emotion regulation, and decision history may influence social decision-making. By conducting separate models on responder behaviour from each

paradigm in parallel, effects that were robust to differences in paradigm and sample characteristics could be identified. Whilst the convergence of results from the models demonstrated support for the replicability of the claims in the present study, attention should nevertheless be drawn to the potential limitation of the sample size at the trial level (Chen et al., 2022).

The general effects of the game were significant across comparisons involving children and adolescents, and consistent with previous studies on adult responder behaviour, as unfair offers: 1) were more likely to be rejected; 2) evoked more negative valence; and were linked to an 3) increased RT when being accepted and decreased RT when being rejected (e.g., Kravitz & Gunto, 1992; Lin et al., 2020). These findings establish support that the responder behaviour of children and adolescents in the Ultimatum Game follows the dual-process account, which may provide the theoretical basis for future work in social decision-making to utilise this paradigm and framework to investigate longitudinal differences and differences in atypically developing populations. This could help to address the gap that has been identified in the context of understanding atypical social decision in a number of neurodiverse populations, where such dynamic assessments have been lacking (e.g., Woodcock et al., 2020).

Despite the expectation of a consistent age effect due to the differing developmental trajectories of the affective and deliberative systems, the effect of age was only found across response variables in the Comments paradigm, and this could not be consistently replicated across paradigms, suggesting that the significant effects related to age may instead be due to differences in paradigm. Furthermore, a previous study using the standard Ultimatum

Game paradigm with responders of a similar age range (*M* = 9.5, *SD* = 2.6) found no correlation between age and acceptance rate of unfair offers (Wang et al., 2019). Therefore, it is possible that the effects of age from the Comments paradigm may reflect developmental differences in theory of mind and reading comprehension, such that older participants were more able to identify the intent behind the proposer comments and respond accordingly (Dore et al., 2018).

In relation to modifications of the paradigm, the addition of comments decreased the likelihood of accepting unfair offers and increased the level of negative valence associated with unfair offers. Specifically, negative comments in unfair trials appeared to drive the decreased odds of acceptance and accentuated the polarising nature of decision on RT. The reduced acceptance rate in the present study is consistent with the findings from a study on adult responder behaviour using similar comments that emphasised the inequity of unfair offers (Kravitz & Gunto, 1992). These results lend support to the hypothesis that negative comments may introduce more conflict between the affective and deliberative systems by provoking a heightened emotional response from responders. However, negative comments did not have the predicted effect on the rating of negative valence in relation to unfair offers, which could be due to insufficient measurement sensitivity with the rating scale or potential ceiling effects elicited by unfair offers.

Although the variation in the stake size was introduced primarily for pragmatic reasons, the analysis revealed that unfair offers of smaller stake sizes decreased the likelihood of acceptance (Four-stakes and Comments paradigms) and the level of negative valence (Four-stakes). The former is consistent with previous work demonstrating that substantial

increases in the stake size of unfair offers incentivised responders to accept (Andersen et al., 2011), whilst the latter contrasted a study reporting no effect of stake size on feelings of contempt or happiness (Tabibnia et al., 2008). However, as these effects were not presently replicated across all three paradigms, caution should be drawn to potential interpretations.

As the pattern of responder behaviour was found to be consistent with the dual-process theory, the present findings provide support for the role of emotion regulation in decision-making for unfair offers in the Ultimatum Game. However, in contrast to the hypothesised relationship between trait emotion regulation and responder behaviour in the game, this study demonstrated no consistent effect of any CEMS subscales on responder behaviour across and within paradigms. This absence of a consistent effect of trait emotion regulation could reflect a limitation of self-report trait measures, which are less able to account for the variability introduced by contexts in daily life (McMahon & Naragon-Gainey, 2020). For example, social processes may affect responder behaviour in the Ultimatum Game, such as the potential motivations for accepting or rejecting an unfair offer (e.g., Yamagishi et al., 2012), which may consequently influence the regulation of momentary emotional states during the game (Aldao et al., 2015; Colombo et al., 2020). Furthermore, the division of the CEMS into their respective subscales according to emotion (anger, sadness, and worry) and type of emotion regulation (inhibition, coping, and dysregulated expression) may be unsuitable for the present study design, as responders in the Ultimatum Game may instead utilise a combination of strategies to regulate general negative affect, as opposed to using individual emotion-specific strategies (Brans et al., 2013; McMahon & Naragon-Gainey, 2020). In the wider context of the construct of self-regulation, which encompasses emotion regulation, evidence appears to suggest that self-report and behavioural measures share low

correlation and potentially capture different latent constructs, which may be pertinent to the present study (Eisenberg et al., 2019; Zeynep Enkavi et al., 2019).

With regards to the effect of the previous decision on responder behaviour in the current unfair trial, consistent effects were observed across paradigms for the three response variables of interest. In line with the choice repetition biases observed in other decision-making paradigms (e.g., Senftleben et al., 2019), responders in the Ultimatum Game were more likely to repeat their previous choice when faced with an unfair offer. Furthermore, the temporal dynamics of decisions in unfair trials were influenced in a similar fashion (e.g., Alós-Ferrer et al., 2016), such that responders were quicker to reach a decision if it was congruent with their previous choice, but they were slower when it conflicted with their previous decision. The choice history of responders also affected the valence associated with subsequent unfair offers, as responders indicated greater levels of negative valence if they had rejected the previous offer. These effects on RT and negative valence rating in child responders are consistent with the conceptualisation of choice history as an additional process that can conflict with the affective and deliberative systems in decision-making (Alós-Ferrer et al., 2016).

Although the paradigms in the present study followed the “one-shot” design of the Ultimatum Game, such that a new proposer was introduced for each offer, the influence of decision history was nevertheless robust across the samples. The persistent bias of choice history has been demonstrated in other domains of decision-making. For example, in a perceptual task, where the presentation of the target stimulus was random and independent across trials, the choice and outcome of the previous trial influenced decision-making of

participants in the subsequent trial (Abrahamyan et al., 2016). Similar to the effects of choice history in the Prisoner's Dilemma (Blake et al., 2015; Grujic et al., 2010; Grujić & Lenaerts, 2020), it is possible that decision history may interact with offer history to influence the degree of reciprocity shown by the responder across repeated rounds of the Ultimatum Game with the same proposer. Therefore, subsequent research should examine whether this choice repetition bias influences repeated play of the Ultimatum Game, in addition to whether this effect is present in adult responders to verify that it is developmentally persistent.

In this article, the responder behaviour of children and adolescents in the Ultimatum Game was demonstrated to follow predictions based on the dual-process theory. Furthermore, the paradigm was conducive to modification, such that the addition of proposer comments influenced some aspects of responder behaviour. Whilst trait emotion regulation appeared to have no clear effect on responder behaviour, a robust choice repetition effect was observed, which is consistent with the view that decision history may interact with the two systems to influence social decision-making.

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Supplementary Information

Supplementary Table S2.1. Structure of trials across the two sessions of computerised Ultimatum Game.

Trial	Session 1			Trial	Session 2		
	Stake size[a]	Fairness	Comment[b]		Stake size[a]	Fairness	Comment[b]
1	£1 (£0.10)	Fair	"Here is my offer..." (Neu)	19	£1 (£0.10)	Unfair	"You will not like my offer!" (Neg)
2	£1	Fair	"What do you say?" (Neu)	20	£1	Unfair	"Take it or leave it!" (Neg)
3	£100 (£10)	Unfair	"Did you really expect half?" (Neg)	21	£100 (£10)	Fair	"Time to decide!" (Neu)
4	£100	Unfair	"I am here to win!" (Neg)	22	£1	Unfair	"It is my money, this is all you are getting!" (Neg)
5	£1 (£0.10)	Unfair	"Here you go!" (Neu)	23	£1 (£0.10)	Unfair	"What do you think?" (Neu)
6	£100	Unfair	"I am keeping most for myself!" (Neg)	24	£100	Unfair	"I am going to win this game!" (Neg)
7	£100	Fair	"Are you ready to decide?" (Neu)	25	£100 (£10)	Fair	"Make your choice!" (Neu)
8	£1	Unfair	"I am the best at this game!" (Neg)	26	£1 (£0.10)	Fair	"It is up to you!" (Neu)
9	£100 (£10)	Unfair	"I have more money than you!" (Neg)	27	£100	Unfair	"This is all I am offering!" (Neg)
10	£1 (£0.10)	Unfair	"I am not giving you half my money!" (Neg)	28	£100 (£10)	Unfair	"Here comes my offer..." (Neu)
11	£100	Unfair	"Your turn!" (Neu)	29	£1	Unfair	"Over to you!" (Neu)
12	£100 (£10)	Unfair	"It is my money!" (Neg)	30	£1 (£0.10)	Unfair	I rule at this game! (Neg)
13	£1 (£0.10)	Unfair	"You are not going to like this!" (Neg)	31	£1	Fair	"Will you accept my offer" (Neu)
14	£100 (£10)	Fair	"Do you like this game?" (Neu)	32	£1	Unfair	"I am not sharing my money!" (Neg)
15	£1 (£0.10)	Fair	"And my offer is..." (Neu)	33	£100	Unfair	"You are not getting half!" (Neg)
16	£100	Fair	"Yes or No?" (Neu)	34	£100 (£10)	Unfair	"I deserve the most money!" (Neg)

Trial	Session 1			Trial	Session 2		
	Stake size[a]	Fairness	Comment[b]		Stake size[a]	Fairness	Comment[b]
17	£1	Unfair	“The big prize is mine!” (Neu)	35	£1	Fair	“I think I will offer...” (Neu)
18	£100 (£10)	Unfair	“What will you decide?” (Neu)	36	£100	Fair	“This is what I am offering!” (Neu)

Neu, Neutral comment; Neg, Negative comment.

[a] Where available, stake sizes in brackets were used instead for trials in the Four-stakes paradigm.

[b] Comments were presented in the Comments paradigm only.

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CHAPTER 3

ESTABLISHING THE TRANSDIAGNOSTIC CONTEXTUAL PATHWAYS OF EMOTIONAL OUTBURSTS

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The data and computer code used to generate the results are publicly available at https://osf.io/2j47e/.

Abstract

Emotional outbursts or temper outbursts are challenging behaviours commonly experienced by people with neurodevelopmental disorders and people who have experienced childhood adversity, which can negatively impact individuals and their families. Emotional outbursts may manifest in different situations via unique pathways distinguished by context-specific differences in the regulation and expression of emotions. Caregivers (*N* = 268) of young people (6-25 years) with emotional outbursts completed a bespoke caregiver-report questionnaire. Potential pathways were identified by examining the patterns of antecedents and setting events related to outbursts through factor and cluster analyses. Six contextual factors were derived from the Emotional Outburst Questionnaire. Based on these factors, the responses were classified into three clusters, which may represent potential pathways of emotional outbursts. The three clusters were characterized by the increased likelihood of outbursts: 1) across all setting events and triggers; 2) in safe setting events; 3) in unsafe setting events. These potential pathways may be related to: 1) differences in sensory processing; 2) masking of emotions in unsafe environments; 3) differences in safety perception. This framework supports a transdiagnostic account of emotional outbursts and may facilitate the development of pathway-specific intervention strategies.

Introduction

Emotional outbursts are prevalent and developmentally persistent in people with neurodevelopmental disorders, and in people who have experienced childhood adversity or trauma (e.g., refs.[1,2]). We define an emotional outburst as a highly emotional, explosive episode, characterized by a pattern of challenging behaviour that varies across individuals and across time, but can be immediately identified by caregivers[3]. Emotional outbursts are often referred to as "temper outbursts" or "tantrums", but other synonymous terms include "meltdowns" and "rages" [4–6].

Phenomenological studies of emotional outbursts have been conducted in individuals with specific diagnoses: in children and adults with Prader-Willi syndrome[7,8], Lowe syndrome[9], and in autistic toddlers[10]. These studies revealed that the behavioural topographies of outbursts are similar across disorders, and comparable to behaviours displayed in tantrums of typically developing toddlers[3,8–11]. Consideration of the antecedents and environmental factors that mediate the likelihood of the occurrence of emotional outbursts (setting events) may be critical to the understanding of outbursts, as an emotional outburst can be considered a product of environmental and biological factors[12]. Previous studies have found that the antecedents and setting events of outbursts varied across individuals within each neurodevelopmental condition, but the overall range of these contexts between conditions appeared to be comparable[7–10]. These findings challenge the conventional perspective of considering emotional outbursts and other challenging behaviours within the bounds of diagnostic constructs, which assumes that emotional and behavioural processes are inherently distinct across individuals with different diagnoses, and that these disparities in

emotion and behaviour can be adequately and solely explained by biological differences linked to the corresponding diagnoses[13]. For example, previous studies have identified sensory stimuli as causes of outbursts for some individuals[5,7,14,15], which could be related to underlying sensory processing difficulties shared by individuals across a wide range of diagnoses (e.g., refs. [16–21]). Thus, it would be unlikely for outbursts caused by sensory stimuli to manifest in ways which are entirely specific to diagnosis.

Further compounding the issue over the utility of a diagnostic framework for studying emotion and behaviour, the diagnostic validity of two of the most common neurodevelopmental psychiatric diagnoses, autism spectrum disorder and attention deficit hyperactivity disorder (ADHD), has been put into question, given that no psychological or neurobiological marker can be consistently found across individuals with either diagnosis[22,23]. The absence of such markers in autistic individuals or individuals with ADHD reinforces the view that diagnostic status may lack explanatory power when considering the aetiology of challenging behaviours such as emotional outbursts, an endeavour which is critical in developing effective intervention. The argument against the use of diagnostic boundaries can be extended to interventions for emotional outbursts and other challenging behaviours, as common strategies, such as psychoactive medications or psychological therapies have transdiagnostic mechanisms of action at a system-level, which lack diagnostic specificity[24,25]. Indeed, policy regarding the management of challenging behaviour for people with intellectual disabilities from the United Kingdom's National Institute for Health and Care Excellence[26] does not place emphasis on diagnostic boundaries. In the recommendations, there is an absence of differential guidance based on the aetiology of the

intellectual disability and these recommendations appear to be based on evidence involving individuals with a range of different conditions[26].

When considering the aetiology of emotional outbursts specifically, this phenomenon has classically been regarded under a purely operant reinforcement framework[27,28]. However, this account appears to have inadequate explanatory power for emotional outbursts[29], as anecdotal and empirical reports from caregivers and autistic young people suggest that outbursts occur due to the individuals losing control[5,14], and that individuals frequently display remorse immediately after outbursts[8,9]. Across diverse fields, emotional outbursts have been traditionally accepted as behavioural manifestations of emotion dysregulation, as reflected by the inclusion of items regarding the existence or frequency of outbursts on emotion dysregulation subscales of both widely used (e.g., Behavior Rating Inventory of Executive Function[30]) and recently developed measures of behaviour problems (e.g., Emotion Dysregulation Inventory[31]). This has created a widely assumed one-to-one mapping between the two constructs, which empirical research to date has seldom addressed or explored in further detail. At present, the link between emotional outbursts and emotion dysregulation requires further refinement to determine how emotion dysregulation may have adequate explanatory power as an aetiological mechanism to explain the variation observed in emotional outbursts across individuals and across time[32].

If emotion dysregulation were indeed central to the aetiology of emotional outbursts, then one might expect differences in the emotional processes that underlie the observed dysregulation (i.e., the regulation and subsequent expression of emotions) to directly influence the variability in the antecedents and setting events associated with emotional

outbursts. This expectation would be consistent with the transdiagnostic perspective regarding outbursts, as emotion regulation has been proposed to be a transdiagnostic domain within the Research Domain Criteria framework, which could account for psychopathology across diagnoses[33,34]. Furthermore, emotion regulation may reciprocally interact with other domains (e.g., cognitive systems[35]), such that differences in these domains could ultimately lead to differences in emotional processes. The context-dependence of emotional processes is a source of variability that could conceivably account for the range of antecedents and setting events associated with emotional outbursts, which would enable the aetiological account of outbursts to be expanded in terms of the differences in emotion regulation or expression that might lead to dysregulation and subsequent outbursts in specific contexts[35–38].

In this expanded framework, it is possible that an individual may experience outbursts in a given set of contexts due to a pattern of context-specific differences in emotion regulation or expression. Such a relationship between the contexts associated with outbursts and the underlying differences in emotion regulation or expression represents a distinct contextual pathway of emotional outbursts. One such pathway has been delineated in individuals with Prader-Willi syndrome who experienced outbursts in response to change-related antecedents (e.g., changes to routines). In this pathway, an impairment in the cognitive ability of task-switching was demonstrated to increase the likelihood of outbursts in response to the demands of change, and this was proposed to be mediated via the emotional impact of the interaction between the cognitive deficit and the specific environmental demand[39–41]. The present framework suggests that this pathway may be transdiagnostic, which is supported by neither change-related outbursts nor differences in

task-switching being exclusive to people with Prader-Willi syndrome (e.g., refs. [9,42]). Notably however, even in people with Prader-Willi syndrome, this pathway can account for outbursts in a proportion of individuals[7]. Thus, we expect additional pathways involving other differences in emotion regulation or expression to account for discrete sets of contexts in which outbursts can occur. Furthermore, whilst biological factors, such as certain genetic syndromes, may predispose an individual to experience outbursts (e.g., ref. [43]), we hypothesise that individual differences in emotion regulation or expression ultimately determine the pathway through which emotional outbursts manifest. We further expect that these differences in emotion regulation or expression can similarly account for emotional outbursts in people who have experienced childhood adversity or trauma, as a broad range of emotional and cognitive differences linked to psychopathology have been reported in this population of individuals (for reviews, see refs. [44–46]).

In this study, informant-report questionnaire responses were used to investigate the contexts of emotional outbursts transdiagnostically using cluster analysis, with the aim of establishing some of the potential contextual pathways of outbursts. Given the scarcity of current literature around the contexts and associated mechanisms of emotional outbursts, we did not hold specific hypotheses about the nature of the pathways that would be identified. However, the analytic strategy in the present study allowed for a balance between statistical robustness and clinical interpretability to ensure meaningful results to serve as a foundation for future work in this area.

Methods

Participants

Participants were recruited from local, regional, and national support groups for individuals with neurodevelopmental disorders based in the United Kingdom, and national support groups in Ireland, North America, and Australia. Several local, regional, and national organizations supporting adoptive and foster families in the United Kingdom assisted in recruitment. Organisations supported recruitment of caregivers by distributing information about the study and the study survey link. The inclusion criteria were that participants must be caring for young people between the ages of 6-25 years, who experienced emotional outbursts at least once a month.

Six responses were excluded due to missing demographic information regarding age, gender, and diagnoses. Nine responses were excluded as the young person's age did not meet the age criterion. The analysis was based on 268 responses with complete Emotional Outburst Questionnaire data. Five of these responses had partially missing demographic information. The mean age of the young people was 13.5 years (*SD* = 5.2; range = 6.1–25.9). There were 162 males (60.4%), 105 females (39.2%), and 1 non-binary individual (0.4%). The mean Social Communication Questionnaire score was 19.5 (*SD* = 8.5; range = 2–36; 1 response missing). Supplementary Table S3.1 presents diagnostic information of the young people.

Seventy young people were medicated for outbursts (26.2%; 1 missing). In terms of support, 130 families have accessed some form of program, training, or intervention for outbursts (49.2%; 4 missing). Of these families, 65 rated the support as effective (50.4%; 1 missing). Young people from 202 families were reported to have special education needs and

disabilities (SEND; 76.5%; 4 missing). Of these families, 160 had a formal statement or plan in place for the young person's SEND (79.2%). Regarding current schooling or employment status: 146 attended mainstream schools (54.9%); 68 attended special schools (25.6%); 11 were in further education (4.1%); 2 were in higher education (0.8%); 9 were employed or in employment preparation (3.4%); and 30 were unemployed (11.3%; 2 missing). A question regarding early traumatic and adverse experiences was added to the survey partway through data collection. In this question, traumatic or adverse events were defined as single or prolonged events causing severe stress, which are different from events typically expected to occur during childhood or adolescence. The following examples of traumatic events were provided: natural disasters; death or serious injury of someone close to the person; poverty; witnessing abuse or violence; emotional, physical, or sexual abuse; neglect. Out of 151 available responses, 73 young people were reported to have experienced early traumatic or adverse events (48.3%; 4 selected *Prefer not to say*; 117 missing). Families were based in the United Kingdom (*n* = 199; 74.3%), North America (*n* = 49; 18.3%), Australia (*n* = 10; 3.7%), and other countries (*n* = 5; 1.9%; 5 missing).

Measures

Emotional Outburst Questionnaire

The Emotional Outburst Questionnaire consists of 133 items divided into three sections (see Appendix 1 for the full questionnaire and Supplementary Methods for details on the development of the measure). Sections 1 and 2 explore the characteristics of the most and least severe outbursts, respectively, which include the behavioural composition, frequency, duration, intensity, and recovery duration of outbursts. Section 3 queries general

characteristics of outbursts, which include setting events and antecedents related to outbursts, behaviours that occur after outbursts, and caregiver management strategies effective in stopping outbursts. Items related to the setting events and antecedents of outbursts are rated on a three-point frequency rating scale with subjective and objective quantifiers: “Not applicable/never/rarely (0-3 times out of 10)”, “Sometimes (4-6 times out of 10)”, “Often/always (7-10 times out of 10)”. Informants are asked to recall outbursts that have occurred within the past month.

Social Communication Questionnaire

The Social Communication Questionnaire[47] (SCQ) is a 40-item informant-based autism spectrum disorder (ASD) screening measure, divided into three domains: reciprocal social interaction, communication, and stereotyped patterns of behaviour. The items within the SCQ were derived from the Autism Diagnostic Interview-Revised[48] (ADI-R). The SCQ demonstrated good internal consistency across developmental ability and age, and good convergent validity with the ADI-R[47].

As many neurodevelopmental disorders are associated with the co-occurrence of ASD[49], the SCQ was used to provide a common measure of social communication deficits within the sample, which may have particular relevance to the aetiology of emotional outbursts. The SCQ was selected over other similar measures, as it is an informant-report measure that is appropriate for individuals of all intellectual abilities and age, which aligned with the study inclusion criteria.

Procedure

The study received ethical approval from the Science, Technology, Engineering and Mathematics Ethical Review Committee at the University of Birmingham and the study was conducted in accordance with relevant guidelines and regulations. After providing informed consent, caregivers completed an anonymous survey consisting of the Emotional Outburst Questionnaire, SCQ, and a demographic questionnaire. Nearly all participants completed the survey online on Qualtrics. One caregiver completed the survey on paper. The median survey completion time was 28 minutes (interquartile range = 43 – 22 = 21 minutes). The Emotional Outburst Questionnaire and demographic questionnaire were completed a second time by original participants or secondary caregivers at least 14 days after initial survey completion on a voluntary basis. Out of the 199 participants invited to complete the survey for a second time, 48 original participants and 10 secondary caregivers completed this second survey.

Statistical analyses

As this article focuses on the contextual pathways of outbursts, analyses of items related to setting events and antecedents are presented. Statistical analysis was undertaken in R 4.0.2.

Test-retest and interrater reliability were measured in terms of Cohen's κ with quadratic weightings.

The latent structure of the 55 items pertaining to both the antecedents and setting events of outbursts were first identified using exploratory factor analysis with maximum likelihood extraction and oblimin rotation, in order to overcome the obstacle presented by the large number of items, such that contexts with similar characteristics would be grouped into

salient factors. The response options were coded as 0 = "Not applicable/never/rarely (0-3 times out of 10)", 0.5 = "Sometimes (4-6 times out of 10)", 1 = "Often/always (7-10 times out of 10)". To further validate the contextual items of the questionnaire, the internal consistency of each factor was evaluated by calculating Cronbach's α using items with loadings ≥ 0.40. Refined and non-refined factor scores were generated for subsequent analysis[50]. Refined factor scores corresponded to standardized regression-based factor scores, which accounted for all item loadings and intercorrelations amongst items and factors[50]. In contrast to refined factor scores, which accounted for all items included in the analysis, non-refined factor scores constituted unweighted averages of only items with loadings ≥ 0.40.

To identify common patterns of contexts in which outbursts occurred, the factor scores of responses were classified into clusters based on squared Euclidean distances between responses. Ward's hierarchical agglomerative clustering[51] was used to identify the suitable number of clusters for subsequent analysis. This approach allowed for exploration of the data at different clustering steps to determine the most appropriate cluster structure in terms of cluster interpretability. Furthermore, *k*-means clustering was performed to provide additional support for the chosen cluster structure, and to demarcate the centroid of each cluster in terms of mean factor scores. The level of agreement between cluster structures was evaluated using Cohen's unweighted κ, which accounts for classification agreements due to chance[52]. To test for the potential impact of using factor scores on the cluster structure, hierarchical clustering was performed on the responses of the 55 items and compared to the results of hierarchical clustering using refined factor scores. There was a

broad level of agreement, as cluster membership was maintained for 190 participants (70.9%; Cohen's $\kappa = 0.56$, 95% CI [0.48, 0.64]).

Refined factor scores were the focus of the cluster analysis as these scores retained more information regarding the factor structure compared to non-refined scores. Cluster analysis was additionally conducted on non-refined factor scores to characterize cluster centroids in terms of factor scores that were less sample-dependent and easier to calculate, thus enabling cluster classification in subsequent samples.

Factor scores were compared between clusters using multivariate analysis of variance (MANOVA). As the assumption of homogeneity of variance between groups was violated for some factors, Welch's ANOVA and post-hoc pairwise Games-Howell tests were selected as follow-up analyses based on their robustness against violations of homogeneous variances. Cluster differences were further assessed with Welch's ANOVA and χ^2 tests of association in terms of SCQ scores and demographic variables for which sufficient data were available. Significant ANOVA and χ^2 tests were followed with post-hoc pairwise Games-Howell and χ^2 tests, respectively. Effect sizes are presented as ω^2 and Cramer's V.

Code availability

The computer code used to generate the results can be found at https://osf.io/2j47e/.

Results

Contextual factors

The test-retest reliability and interrater reliability of the contextual items were κ = 0.63 (95% confidence interval (CI) = 0.59, 0.68) and κ = 0.63 (95% CI = 0.54, 0.72), which indicated moderate agreement.

For the exploratory factor analysis of the contextual items, parallel analysis[53], the Very Simple Structure criterion[54], and Kaiser's criterion of retaining factors with eigenvalues ≥ 1[55] all indicated that six factors were optimal. The six-factor solution accounted for 32.4% of variance (Table 3.1).

The factors were interpreted as: 1) Sensory (eigenvalue = 9.60; variance explained = 6.8%; Cronbach's α = 0.83), which contained items related to sensory hypersensitivity; 2) Cognitive Demand (eigenvalue = 3.79; variance explained = 6.6%; α = 0.79), which consisted of antecedents that might place additional cognitive demand on individuals; 3) Threat to Self (eigenvalue = 1.98; variance explained = 6.6%; α = 0.84), which encompassed antecedents that might be perceived as a threat to the concept of self for individuals; 4) Cross-settings (eigenvalue = 1.86; variance explained = 5.2%; α = 0.78), which included a range of settings and people with whom individuals were more likely to experience outbursts; 5) Safety (eigenvalue = 1.54; variance explained = 4.0%; α = 0.68), which consisted of settings and people associated with safety; 6) States (eigenvalue = 1.35; variance explained = 3.3%; α = 0.68), which included the physiological states, such as tiredness and hunger or thirst.

Table 3.1 Loadings of contextual items from the Emotional Outburst Questionnaire onto six factors.

Item	Factor loading					
	1	2	3	4	5	6
Separation from caregiver	**0.41**	0.07	0.14	0.21	-0.05	-0.03
Not understand what is going on	**0.44**	0.24	0.16	0.03	0.06	-0.05
Light is too bright	**0.57**	-0.09	0.12	0.10	-0.01	0.02
Sudden or loud noises	**0.59**	0.07	-0.08	0.09	-0.03	-0.07
Temperature is too hot or too cold	**0.53**	-0.04	0.17	0.08	-0.04	0.15
Particular smells or strong smells	**0.64**	-0.08	0.23	-0.03	-0.09	0.03
Touch-related over-sensitivity	**0.58**	0.00	0.09	0.14	0.10	-0.04
Other sensory-related triggers	**0.56**	0.10	-0.14	0.11	0.08	0.03
Change in own routine	0.32	**0.50**	-0.21	-0.04	-0.04	0.14
Change in another's routine	0.30	**0.51**	-0.12	0.06	0.01	0.02
Change in expectation	0.07	**0.50**	0.11	-0.07	0.02	0.06
Being fixated on a thought or idea	-0.01	**0.45**	0.07	-0.03	0.07	0.00
Individual’s demand not met	-0.22	**0.58**	0.09	0.02	0.02	0.13
Individual waiting for demand to be met	-0.10	**0.68**	-0.03	0.08	0.00	0.05
Demand placed on individual	-0.08	**0.62**	0.13	-0.02	-0.02	-0.02
Boring task	-0.06	**0.47**	0.21	0.07	0.09	-0.15
Disagreement with others	-0.06	0.10	**0.69**	0.02	0.07	0.05
Being criticized	0.01	0.08	**0.71**	-0.04	0.10	-0.01
Being teased	0.13	0.01	**0.70**	0.03	-0.15	0.01
Feeling of being treated unfairly	0.06	-0.03	**0.76**	-0.09	0.03	0.11
Receiving conflicting information	0.35	0.15	**0.43**	0.03	0.11	-0.12
Unsafe setting	0.00	0.16	0.04	**0.44**	-0.32	0.11
Familiar setting	0.05	-0.13	-0.06	**0.45**	0.39	0.12
Public setting	0.08	0.09	-0.25	**0.65**	0.00	0.11
Unsafe person	0.18	0.01	0.01	**0.54**	-0.22	-0.02
Familiar person	-0.11	-0.06	0.11	**0.58**	0.02	-0.02
Unfamiliar person	0.16	0.04	-0.10	**0.65**	-0.02	-0.04
A person the individual dislikes	-0.07	0.08	0.18	**0.59**	-0.24	0.00
Safe setting	0.03	0.05	-0.01	-0.11	**0.79**	-0.01
Private setting	0.13	0.05	0.10	-0.02	**0.51**	0.01
Safe person	-0.06	0.03	0.03	-0.04	**0.72**	0.08
A person the individual likes	-0.03	-0.19	0.07	0.30	**0.42**	0.01
Tired	-0.08	0.08	0.04	0.05	0.13	**0.60**
Hungry or thirsty	-0.04	-0.01	0.15	0.04	0.05	**0.70**
Unfamiliar setting	0.14	0.07	0.01	0.40	-0.03	0.22

Item	Factor loading					
	1	2	3	4	5	6
A person the individual is jealous of	-0.12	0.08	0.27	0.22	-0.03	0.23
Consuming too much of one type of food or drink	0.05	0.05	0.09	0.04	0.01	0.34
Illness	0.27	-0.01	-0.26	-0.06	-0.18	0.40
In pain	0.38	-0.01	-0.18	0.01	-0.06	0.38
In a bad mood	0.00	0.15	0.19	-0.05	-0.03	0.29
Planned transition	0.19	0.37	-0.12	0.03	0.03	0.02
Specific phobia or fear	0.18	0.22	0.21	0.16	-0.04	0.06
Food-related triggers	0.21	0.03	0.16	-0.03	0.09	0.26
Concerns for own property	0.24	0.15	0.31	-0.07	0.00	0.12
Difficult task	0.10	0.31	0.25	0.15	0.07	-0.08
Repetitive task	0.03	0.40	0.09	0.13	0.14	-0.12
New task	0.24	0.40	0.16	0.10	0.01	-0.07
Under time pressure	0.32	0.22	0.31	-0.09	0.09	0.04
Not receiving enough attention	-0.14	0.35	0.15	0.06	-0.04	0.09
Receiving too much attention	0.24	0.11	0.15	0.17	0.09	-0.13
The Individual not being understood	0.27	0.16	0.30	0.18	-0.11	-0.08
Not understanding someone else	0.25	0.17	0.40	0.11	0.06	-0.03
Medication side-effect	0.16	0.05	-0.13	0.11	0.06	0.04
Mood of caregiver	0.06	0.26	0.02	-0.07	0.02	0.11
No reason or out of the blue	0.03	0.30	-0.06	0.12	0.19	-0.04

Loadings ≥ 0.40 in bold. Loadings rounded up to 0.40 are not in bold and were not included in Cronbach's α or non-refined factor score calculations.

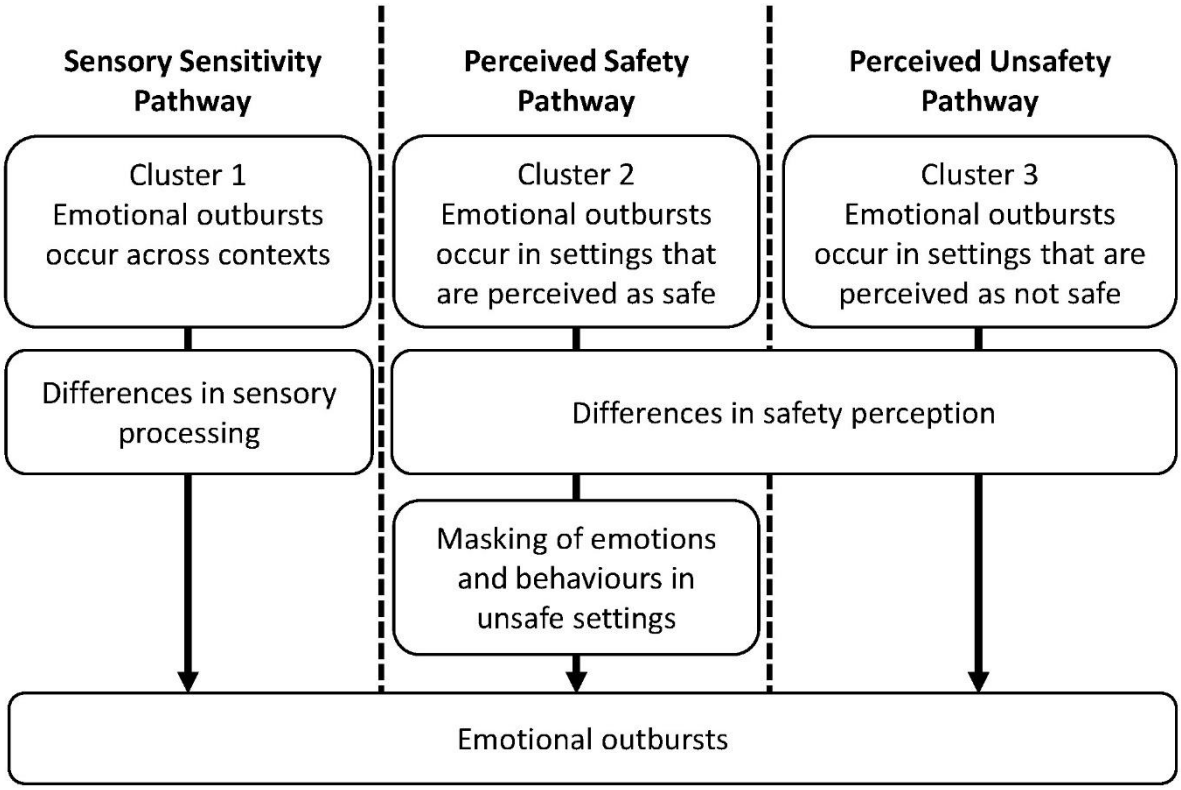
Contextual clusters

Clusters based on refined factor scores

Responses were classified into clusters using refined factor scores, which were standardized around means of 0. A three-cluster solution with distinct and interpretable clusters emerged from hierarchical clustering. *K*-means clustering with $k = 3$ provided additional support for this cluster structure, as cluster membership was maintained across clustering methods for 220 participants (82.1%; Cohen's $\kappa = 0.73$, 95% CI [0.66, 0.80]). Based on the results from the

cluster analysis, the clusters were ascribed the following labels: 1) Sensory Sensitivity; 2) Perceived Safety; 3) Perceived Unsafety (Figure 3.1).

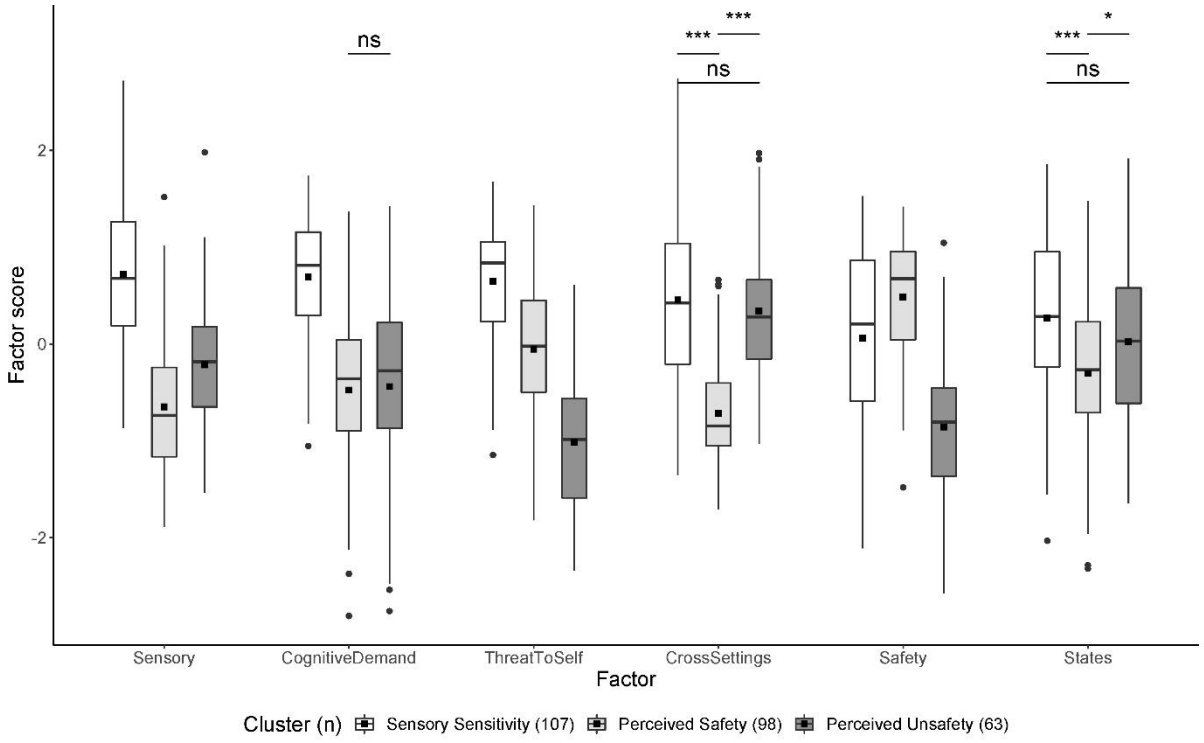
Figure 3.1 Summary of the description and interpretation of the contextual pathways of emotional outburst, corresponding to the three identified clusters.



Comparing the mean factor scores between the three clusters revealed a significant difference (Pillai Trace = 0.651, $F(6, 261) = 81.034$, $p < 0.001$, $\omega^2 = 0.642$, 95% CI [0.559, 0.700]). Subsequent univariate tests indicated that mean scores for all six factors significantly differed between the three clusters (Table 3.2). Most post-hoc pairwise comparisons demonstrated significant differences (Figure 3.2; Supplementary Table S3.2). The mean factor scores of the Sensory Sensitivity cluster were generally greater than those

of the Perceived Safety and Perceived Unsafety clusters. The Perceived Safety cluster was characterized by a greater mean score in the Safety factor compared to other clusters. The mean scores of the Perceived Unsafety cluster in the Cross-settings and States factors were comparable to the Sensory Sensitivity cluster, and greater than those of the Perceived Safety cluster.

Figure 3.2 Pairwise comparisons of factor scores for the k-means three-cluster solution.



Boxplots show mean (black squares) median (horizontal bar), interquartile range (box), range (whiskers) and outliers (circles). All outliers were included in analyses. Unless otherwise specified, all pairwise comparisons within each factor were significant at $p < 0.001$, adjusted with Tukey's method. Ns not significant; * $p < 0.05$.

Table 3.2 Univariate comparisons of refined factor scores for the k-means three-cluster solution.

Factor	Cluster Mean (*SD*)			Welch's *F*	ω^2	95% CI	Post-hoc summary [a]
	SS (*n* = 107)	PS (*n* = 98)	PU (*n* = 63)				
Sensory	0.72 (0.75)	-0.65 (0.67)	-0.21 (0.65)	$F(2, 161) = 97.0^{***}$	0.417	[0.252, 0.561]	1 > 3 > 2
Cognitive Demand	0.70 (0.59)	-0.48 (0.76)	-0.44 (0.89)	$F(2,143) = 92.5^{***}$	0.406	[0.231, 0.558]	1 > 2, 3
Threat to Self	0.65 (0.59)	-0.05 (0.74)	-1.02 (0.74)	$F(2, 149) = 118.6^{***}$	0.467	[0.297, 0.608]	1 > 2 > 3
Cross-settings	0.46 (0.90)	-0.72 (0.53)	0.34 (0.71)	$F(2, 150) = 91.8^{***}$	0.404	[0.234, 0.553]	1, 3 > 2
Safety	0.06 (0.88)	0.49 (0.61)	-0.86 (0.72)	$F(2, 155) = 75.1^{***}$	0.356	[0.190, 0.508]	2 > 1 > 3
States	0.27 (0.84)	-0.31 (0.79)	0.02 (0.88)	$F(2, 154) = 12.7^{***}$	0.080	[0.003, 0.209]	1, 3 > 2

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety. *p* and confidence intervals adjusted with Bonferroni correction.

[a] Pairwise Games-Howell tests adjusted with Tukey's method. *** $p < 0.001$.

Differences in demographics between clusters were assessed with ANOVA and χ^2 tests for variables with sufficient data (Table 3.3). No difference was found between the clusters in terms of age and gender of the young person, access to medication, access to support, or diagnoses of specific learning difficulties, anxiety, or depression. Exposure to early trauma was more associated with the Sensory Sensitivity and Perceived Safety clusters than the Perceived Unsafety cluster. Diagnoses of ASD, attention deficit hyperactivity disorder, or sensory processing difficulties were more associated with the Sensory Sensitivity cluster. A diagnosis of intellectual disability was more associated with the Perceived Unsafety cluster. It is important to note that despite these diagnostic associations for each cluster, not all individuals with a given diagnosis were exclusively classified to the associated cluster (e.g., there were individuals with sensory processing difficulties in all three clusters), indicating that diagnosis was not the sole determinant of cluster membership. Whilst other diagnoses could not be reliably compared, individuals who shared these diagnoses were also distributed across the three clusters.

Table 3.3 Demographics by cluster for the k-means three-cluster solution using refined factor scores.

Variable	Cluster			Statistic	Effect size [a]	95% CI	Post-hoc summary [b]
	SS	PS	PU				
n	107	98	63				
Age							
Mean	13.0	13.5	14.4	$F(2, 150) = 1.25$	0.002	[0, 0.023]	
SD	4.9	5.1	5.9				
Gender (%)				χ^2 (2) = 4.37 [c]	0.128	[0.034, 0.264]	
Male	68.2	54.1	57.1				
Female	31.8	44.9	42.9				
Non-binary	0	1.0	0				
Diagnosis (%) [d]							
ID	20.6	26.5	46.0	χ^2 (2) = 12.93 **	0.220	[0.112, 0.357]	3 > 1
LD	17.8	10.2	6.3	χ^2 (2) = 5.42	0.142	[0.052, 0.258]	
ADHD	35.5	15.3	15.9	χ^2 (2) = 14.29 ***	0.231	[0.115, 0.347]	1 > 2, 3
ASD	57.9	36.7	54.0	χ^2 (2) = 9.94 **	0.193	[0.090, 0.319]	1 > 2
Anxiety	43.9	36.7	25.4	χ^2 (2) = 5.85	0.148	[0.047, 0.269]	
Depression	9.3	8.2	6.3	χ^2 (2) = 0.47	0.042	[0.017, 0.174]	
SPD	16.8	5.1	3.2	χ^2 (2) = 12.00 **	0.212	[0.102, 0.330]	1 > 2, 3 [e]
Medication (%)							
Yes	28.0	20.4	31.7	χ^2 (2) = 2.94	0.105	[0.029, 0.238]	
Access to support (%)							
Yes	55.1	45.9	41.3	χ^2 (2) = 3.02	0.107	[0.031, 0.240]	
Trauma (%) [f]							
Yes	26.2	35.7	15.9	χ^2 (2) = 13.38 **	0.302	[0.172, 0.467]	1, 2 > 3

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety; ID, intellectual disability; LD, specific learning difficulties; ASD, autism spectrum disorder; ADHD, attention deficit hyperactive disorder; SPD, sensory processing disorder/difficulties.

[a] ω^2 for ANOVA and Cramer's V for χ^2 tests.

[b] Pairwise χ^2 tests adjusted with Bonferroni correction.

[c] Non-binary response excluded for χ^2 test on gender.

[d] Percentage of individuals in each cluster with a given diagnosis. Each caregiver could indicate more than one diagnosis for the multiple-choice question in the survey, so diagnoses were not mutually exclusive and individuals with co-occurring conditions were included in the percentages. Other diagnoses were not included due to insufficient endorsement for statistical comparisons.

[e] Pairwise comparison between the Perceived Safety and Perceived Unsafety clusters not conducted due to insufficient data.

[f] Percentage of caregivers in each cluster who indicated that their child or young person has experienced early traumatic or adverse events. The proportion of individuals in each cluster for whom trauma data were available for χ^2 analysis (i.e., selected either *Yes* or *No*) were: 43.9% of the Sensory Sensitivity cluster; 61.2% of the Perceived Safety cluster; 63.5% of the Perceived Unsafety cluster.

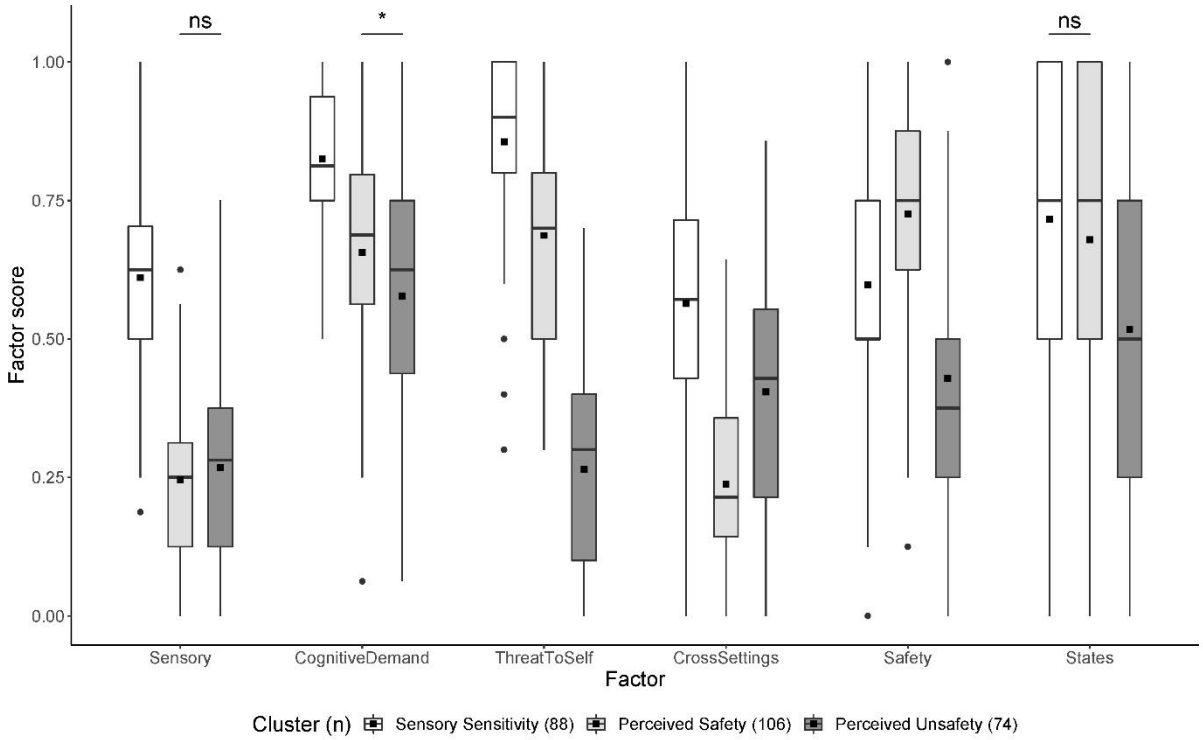
** $p < 0.01$; *** $p < 0.001$.

Consistent with the higher proportion of autistic individuals in the Sensory Sensitivity and the Perceived Unsafety clusters, scores on the Social Communication Questionnaire[47] (SCQ) were significantly higher in these clusters compared to the Perceived Safety cluster across all domains and total score (Supplementary Tables S3.3 and S3.4).

Clusters based on non-refined factor scores

To further validate the three-cluster structure obtained from clustering refined factor scores, responses were classified independently based on non-refined factor scores via *k*-means clustering. The two separate cluster solutions using either refined or non-refined factor scores demonstrated agreement for 219 responses (81.7%; Cohen's $\kappa = 0.72$; 95% CI [0.65, 0.79]). There was a significant difference in non-refined factor scores between the three clusters (Pillai Trace = 0.558, $F(6, 261) = 54.991$, $p < 0.001$, $\omega^2 = 0.547$, 95% CI [0.451, 0.615]). When explored with subsequent univariate and pairwise comparisons, the differences in non-refined factor scores were largely congruent with those found in refined scores (Figure 3.3; Table 3.4 and Supplementary Table S3.5).

Figure 3.3 Pairwise comparisons of non-refined factor scores for the k-means three-cluster solution.



Boxplots show mean (black squares) median (horizontal bar), interquartile range (box), range (whiskers) and outliers (circles). All outliers were included in analyses. Unless otherwise specified, all pairwise comparisons within each factor were significant at $p < 0.001$, adjusted with Tukey's method. Ns not significant; * $p < 0.05$.

Table 3.4 Univariate comparisons of non-refined factor scores for the *k*-means three-cluster solution.

Factor	Cluster Mean (*SD*)			Welch's *F*	ω^2	95% CI	Post-hoc Summary [a]
	SS (*n* = 88)	PS (*n* = 106)	PU (*n* = 74)				
Sensory	0.61 (0.18)	0.25 (0.17)	0.27 (0.17)	$F(2, 166) = 118^{***}$	0.466	[0.305, 0.600]	1 > 2, 3
Cognitive Demand	0.83 (0.13)	0.66 (0.18)	0.58 (0.21)	$F(2, 160) = 49.6^{***}$	0.266	[0.115, 0.420]	1 > 2 > 3
Threat to Self	0.86 (0.18)	0.69 (0.18)	0.26 (0.19)	$F(2, 168) = 217^{***}$	0.617	[0.477, 0.723]	1 > 2 > 3
Cross-settings	0.56 (0.21)	0.24 (0.15)	0.40 (0.21)	$F(2, 153) = 77.3^{***}$	0.363	[0.195, 0.515]	1 > 3 > 2
Safety	0.60 (0.25)	0.73 (0.20)	0.43 (0.22)	$F(2, 165) = 42.8^{***}$	0.238	[0.095, 0.390]	2 > 1 > 3
States	0.72 (0.27)	0.68 (0.26)	0.52 (0.30)	$F(2, 164) = 10.6^{***}$	0.067	[0.000, 0.185]	1, 2 > 3

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety. *p* and confidence intervals adjusted with Bonferroni correction.

[a] Pairwise Games-Howell tests adjusted with Tukey's method. *** $p < 0.001$.

Discussion

The primary aim of this article was to establish some of the potential contextual pathways of emotional outbursts, primarily in young people with neurodevelopmental disorders and in young people who have experienced early trauma. This was achieved by first extracting and then clustering salient factors related to antecedents and setting events from items within the Emotional Outburst Questionnaire. The resulting three-cluster solution was robust across clustering methods and factor calculation methods. As the non-refined scores are less sample-dependent, this factor calculation method offers generalizability and additional utility, allowing for future classification of new responses[50]. Individuals within the three clusters exhibited unique patterns of contexts in which outbursts occur. The potential contextual pathways and associated mechanisms of emotional outbursts represented by the clusters are presented in Figure 3.1.

The Sensory Sensitivity pathway consisted of high scores across contextual factors, indicating that young people within this cluster frequently experienced emotional outbursts across most antecedents and setting events. Accounting for the high Sensory factor scores, it is possible that outbursts for individuals within this cluster may be underpinned by differences in sensory processing, as the additional demands from sensory stimuli may interfere with the cognitive and emotional resources required to mitigate outbursts. This difference in sensory processing may underlie emotional outbursts across other seemingly unrelated contexts for young people in this cluster, as background sensory stimuli may hinder their ability to respond effectively to the contexts in question.

In prior studies, autistic people and their caregivers have described differences in sensory processing as contributing to both anxiety and subsequent meltdowns, demonstrating the capacity for sensory stimuli to act as antecedents of outbursts[5,14,15]. Furthermore, atypical sensory processing in autistic children was associated with 1) increased physiological arousal within a social interaction paradigm, which was suggested to represent an increase in perceived stress, and 2) stress in daily life of the children, as reported by caregivers[16]. These associations indicate that for people with atypical sensory processing, background sensory stimuli may be stressors that could act as setting events and increase the likelihood for antecedents to lead to outbursts.

The current literature has primarily focused on the symptomatology and aetiology of atypical sensory processing within the context of autism (e.g., ref. [17]). Regarding individuals with other neurodevelopmental disorders, atypical sensory processing has been documented in children with ADHD[18], across different genetic syndromes (e.g., ref. [19]), and in children who have experienced maltreatment[20]. Overall, the potential role of atypical sensory processing in emotional outbursts has received little attention. However, it is conceivable that atypical sensory processing may be involved in outbursts for young people in the Sensory Sensitivity cluster, and that this pathway may be transdiagnostic, as the demographic variables associated with this cluster, namely exposure to trauma, diagnoses of ASD, ADHD, or sensory processing difficulties, have been linked to atypical sensory processing.

Individuals in the Perceived Safety pathway were characterized by high Safety scores and low Cross-settings scores, suggesting that emotional outbursts were more likely to occur in

environments perceived to be safe. This pattern of contexts has been observed by Cressey et al. [9] in interviews with caregivers of individuals with Lowe syndrome, who reported that no outbursts occurred outside the home. In the wider context of challenging behaviours, caregivers, whose children were autistic and had at least one concurrent externalizing disorder, rated their children's challenging behaviours as more severe compared to teachers[56]. A potential explanation for this discrepancy between informants may be the context dependence of challenging behaviours that is reflected in young people in the Perceived Safety cluster.

A possible mechanism for emotional outbursts in the Perceived Safety cluster may be related to the *generalized unsafety theory of stress*, which posits that when perceived safety is low, individuals exhibit a default stress response driven by the intolerance of uncertainty about safety, even in the absence of explicit stressors[57]. When perceived safety is high, the theory suggests that top-down control is exerted to efficiently inhibit this default stress response[57]. Individuals in the Perceived Safety cluster may perceive environments as less safe and therefore experience more distress in these environments. Indeed, the environmental influence of childhood adversity on safety perception may explain the association of exposure to early trauma with the Perceived Safety cluster[46]. More critically however, individuals in this cluster may be masking their default stress response in such environments. This process of masking is present in the general population (e.g., ref. [58]), but it has largely been explored in the context of camouflaging autistic traits. For instance, autistic individuals reported increased likelihood to camouflage in social environments perceived to be unsafe, such as when people other than close friends and family were present[59,60]. Furthermore, individuals may be motivated to suppress distress that could manifest as emotional

outbursts to maintain social desirability amongst peers[61]. For individuals who have experienced childhood adversity or trauma, the motivation to suppress distress and maintain social desirability may be further exacerbated by heightened feelings of shame, which may account for the association of this cluster with exposure to early trauma[62]. When considering the consequences of camouflaging, autistic individuals commonly described the process as exhausting, and successful camouflaging for young people meant that teachers were often unaware of the difficulties that students were facing[59,60]. This "bottling up" of distress when in unsafe environments, which has been anecdotally reported by caregivers of individuals who experience outbursts, may subsequently manifest as emotional outbursts when individuals return to a safe environment, where individuals are not actively suppressing their distress. Additionally, the exhaustion associated with masking may interfere with the ability for individuals to exert top-down control over their default stress response once they return to a safe environment, thus increasing the potential for antecedents to cause outbursts. This pathway may account for the higher proportion of individuals who have experienced traumatic or adverse events within the Perceived Safety cluster, who are more likely to have differences in safety perception[46].

Young people in the Perceived Unsafety pathway appeared to have a specific difficulty with environments that were not perceived to be safe, suggested by the combination of high Cross-settings and low Safety factor scores. It is important to note that items related to familiar environments loaded strongly onto the Cross-settings factor alongside items related to unsafe or unfamiliar environments, so outbursts for individuals within this cluster were not dependent on environmental novelty. Moreover, although these items may be diametrically opposed, they are not mutually exclusive, as both types of setting events can

contribute to the outbursts of a given individual. Due to the relatively high incidence of intellectual disability within the Perceived Unsafety cluster, one may be tempted to adopt a functional perspective when considering the aetiology of outbursts for individuals in this cluster, as challenging behaviours have been argued to serve communicative functions, especially for individuals with intellectual disability, who may have impaired communication ability[27]. However, the extensive body of work examining challenging behaviours in people with intellectual disabilities from a functional perspective has highlighted demand avoidance, access to preferred items or events, and access to social attention as being the primary motivators (establishing operations) for behaviour[28]. Presently, demand avoidance and access to preferred items or events were comprised within the factor labelled Cognitive Demand, for which the mean score for the Perceived Unsafety cluster was relatively low. Furthermore, the item relevant to access to social attention was not included in any of the derived factors. However, from a functional perspective, one might expect these items to feature more prominently within the Perceived Unsafety cluster.

In contrast, the pattern of relevant contexts for individuals in the Perceived Unsafety cluster appears to be consistent with the generalized unsafety theory of stress as described above[57]. It is possible that due to differences in safety perception or inhibition of the default stress response, young people in this cluster may be more intolerant of uncertainty about safety and perceive more environments as unsafe. Unlike individuals in the Perceived Safety cluster, individuals in the Perceived Unsafety cluster may not be actively suppressing their default stress response in these unsafe environments, which may be a consequence of comparatively lower motivation and/or lower ability to suppress such distress. The experience of stress or anxiety across environments with low perceived safety may

consequently increase the individuals' susceptibility to emotional outbursts within these environments. Indeed, several neurodevelopmental disorders associated with outbursts have been linked to heightened intolerance of uncertainty (e.g., refs. [11,21]), which would support the possibility of such differences in safety perception being a transdiagnostic mechanism for emotional outbursts.

Mechanistically, the differences in safety perception may arise from disrupted associative learning. Such a cognitive impairment has been demonstrated in individuals with intellectual disability, in terms of differences in association retention in adults with intellectual disability compared to typically developing controls[63], and in terms of differences in profiles of associative memory between individuals with Down syndrome and Williams syndrome[64]. From a neurobiological perspective, the potential failure to fully inhibit the default stress response in a safe environment may also account for the association of this cluster with intellectual disability, as differences in prefrontal regions have been observed in individuals with intellectual disability (e.g., ref. [65]).

According to the proposed pathways, the three clusters appear to be characterized by sensitivity to specific setting events, during which individuals may be less able to cope with antecedents. Although distinct diagnostic factors were associated with each cluster, it should be emphasized that the differences proposed to underlie each pathway are not exclusive to the identified diagnoses. The lack of clusters characterized by specific antecedents suggests that antecedents may be secondary to setting events, when considering the framework of contextual pathways. It is possible that setting events and antecedents could be organized into a hierarchy, in which the first level is determined by setting events (Sensory Sensitivity,

Perceived Safety, and Perceived Unsafety), followed by subdivisions of the pathways according to antecedents. As with the sensitivity to specific setting events, differences in emotion regulation or expression may lead to individuals struggling with specific antecedents (e.g., changes to routines). However, it is possible that setting events could sufficiently hinder the ability for some individuals to regulate their emotions, such that any additional demand, regardless of susceptibility to specific antecedents, could lead to outbursts.

Attention should be drawn to additional findings that were beyond the original aims of this study. The concern expressed by stakeholders over the use of the term “temper outbursts” during questionnaire development should be emphasized, as this terminology, along with “tantrums” has been frequently used within the literature of challenging behaviours in individuals with neurodevelopmental disorders. However, many caregivers found these terms to be inappropriate because the terms imply that 1) individuals are in control of their outbursts; and 2) outbursts are related mostly to anger. Therefore, it is of critical importance for researchers and professionals to recognize and respect the preferences of families and communities to avoid perpetuating stigma and inaccurate representations of emotional outbursts in people with neurodevelopmental disorders. It should be further noted that the term “meltdowns” was acceptable and sometimes preferred by families. Overall, it would be valuable for future work to evaluate the preferences of families and individuals on outburst terminology more systematically to provide further insight and guidance for researchers and professionals.

Nearly half of the caregivers asked about early traumatic or adverse events reported that their children had been exposed to early trauma. Whilst this may have been influenced by some sampling bias, most recruitment channels used to promote this study were not oriented to trauma-affected individuals. Thus, the relationship between trauma and emotional outbursts should be further explored and accounted for in future work.

Finally, it should be noted that half of the caregivers in this study received no formal support for emotional outbursts. Furthermore, even in families who had access to support, only half reported that the resources were effective. Whilst there is undoubtedly sampling bias that would influence the proportion of responses observed, it is evident that current support systems are limited in both availability and suitability. Therefore, the accessibility and scalability of future interventions and support should be considered to maximize the impact on individuals and families. It is possible that the degree of support accessed may have influenced a caregiver's ability to identify and accurately report the contexts of emotional outbursts within the present study. Whilst this factor should be considered and potentially controlled for in future work, it would be worthwhile to additionally explore how widespread support could be provided to families to enable more accurate identification and reporting of outburst characteristics.

The primary limitation for this study is the likelihood that not all contextual pathways have been identified, as more uncommon pathways might be overshadowed by one of the three clusters. Furthermore, the low number of responses collected from families with some genetic syndromes or conditions not typically associated with emotional outbursts (e.g., eating disorders) constrained the ability to explore syndrome- or disorder-specific

differences in cluster membership. Indeed, our understanding of the relationship between emotional outbursts and many of these diagnoses is limited due to the lack of prior research in these areas. However, the inclusion of individuals with a wide range of diagnoses in the present study may provide the necessary impetus for future work to explore and characterise specific diagnostic differences. A further limitation is that an individual's outbursts may be related to more than one pathway (e.g., for some autistic individuals, who may be sensitive to both sensory stimuli and the safety of the environment), which was unaccounted for with the current classification method, but the use of more sophisticated clustering algorithms (e.g., subspace multi-clustering methods; for review, see ref. [66]) may overcome this limitation. Lastly, the analysis was based on responses to an author-derived measure, which lacked previous validation or standardisation of the constructs being measured. Despite this limitation, the use of this measure was necessary, as there was a distinct lack of measures from the existing literature that would have been appropriate for the present aims. Moreover, the Emotional Outburst Questionnaire was based on previously validated measures and some aspects of its validity were demonstrated in the present study.

In terms of future directions, this study provides the foundation for a transdiagnostic approach to characterize and explore the contextual pathways of emotional outbursts. It is possible that the distribution of individuals within each contextual cluster may vary across genetic syndromes and other diagnoses, which may provide further insight into the mechanisms underlying each pathway. Furthermore, the proposed pathways warrant further investigation, in terms of assessing their face validity to families, and verifying and expanding on the mechanisms associated with each pathway. Ultimately, operating under this framework may facilitate the development of pathway-specific intervention strategies.

For example, interventions targeting outbursts in the Perceived Safety pathway may include components that enable individuals to self-regulate in unsafe environments to prevent the build-up of distress and additionally consider the underlying motivations for masking.

The current article presented the Emotional Outburst Questionnaire as a new tool to characterize and classify emotional outbursts in terms of related contexts in children and young people with neurodevelopmental disorders or early traumatic experiences. Three potential contextual pathways and their associated mechanisms were established. The three pathways were proposed to be related to specific environmental sensitivities of individuals and their response to these aspects of the environment, which might limit the ability for individuals to regulate their emotions and behaviours in response to antecedents.

Data availability

The data analysed in this study can be found at https://osf.io/2j47e/.

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Supplementary Information

Supplementary Methods

The Emotional Outburst Questionnaire was developed to transdiagnostically measure the characteristics of outbursts in young people (aged 6-25 years) via informant report. Characteristics of emotional outbursts have been commonly assessed using various informant-report semi-structured interview schedules and questionnaires in typically developing individuals (e.g., refs. [1,2]) and individuals with specific neurodevelopmental disorders[3–7]. These existing measures of outbursts informed the development of the Emotional Outburst Questionnaire (Supplementary Table S3.6). Some measures were directly related to emotional outbursts, whilst others considered the wider context of challenging behaviours, of which outbursts are an example.

Broad categories of outburst characteristics were identified, resembling the categories from studies of outbursts in people with Prader-Willi syndrome[5,6]. This article specifically focused on the contextual categories of Setting events and Antecedents (Supplementary Table S3.7), as the development and analysis of the other sections of the Emotional Outburst Questionnaire will be reported in a subsequent article. Items pertaining to emotional outbursts from the existing measures were compiled into an exhaustive list. Related items were combined to reduce the number of items.

The first author collected feedback from caregivers and professionals on a prototype version of the Emotional Outburst Questionnaire. Stakeholders were recruited based on recommendations from support groups, and through connections with the research team. Twenty caregivers of young people (mean age 11.5 years; standard deviation (*SD*) = 4.1;

range = 4–21; 17 male and 7 female; see Supplementary Table S3.8 for diagnostic information) exhibiting difficulties with outbursts provided feedback in focus group or one-on-one interview settings. Further feedback was obtained via interviews or written communications from four professionals with experience in working with young people with neurodevelopmental disorders across various settings (one special schoolteacher, three clinical psychologists). Interviews and focus groups were recorded and transcribed, supplemented by notes made during the sessions.

Stakeholders assessed the prototype questionnaire in terms of the relevance of each item, the comprehensibility of the questionnaire, and the comprehensiveness of the measure. Specific focus was directed to the wording of instructions and items, and the lists of examples at the end of items to ensure that key examples were included. The interpretations of rating scales were assessed to ensure consistency in interpretation across individuals. Following a round of revision, stakeholders were invited to provide further feedback on the revised version. One stakeholder provided additional comments, which were incorporated into the final design.

The final version of the questionnaire involved the following amendments: addition of a suitable recall period, addition and removal of items, rearrangement of item order, and rewording of items and instructions. One of the most significant changes was the transition away from the term “temper outburst” due to its negative connotations and associations with “temper tantrum”. Examples of specific changes pertaining to the context of outbursts included additions of the following items: “Specific phobia or fear”, “Food-related triggers”, and “Not understanding what is going on”.

Supplementary Table S3.1 Diagnostic information of young people whose caregivers completed the survey.

Diagnosis	*n*	%
Neurodevelopmental		
Intellectual disability	77	28.7
Specific learning difficulties [a]	33	12.3
Attention deficit hyperactive disorder	63	23.5
Autism spectrum disorder	132	49.3
Cornelia deLange syndrome	15	5.6
CHARGE syndrome	7	2.6
DiGeorge syndrome	2	0.7
Down syndrome	4	1.5
Fragile X syndrome	2	0.7
RASopathies [b]	9	3.4
Prader-Willi syndrome	9	3.4
Tuberous sclerosis complex	6	2.2
Williams syndrome	14	5.2
Klinefelter syndrome	2	0.7
Other genetic disorders	8	3.0
FASD and other prenatal drug exposure	14	5.2
Idiopathic neurodevelopmental disorders	3	1.1
Psychiatric		
Anxiety	99	36.9
Attachment difficulties/disorders	19	7.1
Borderline personality disorder	2	0.7
Communication disorders	4	1.5
Demand avoidance	7	2.6
Depression	22	8.2
Disruptive, impulse control, and conduct disorders	7	2.6
Eating disorders	2	0.7
Mood disorders	2	0.7
Obsessive-compulsive disorder	5	1.9
Post-traumatic stress disorder	3	1.1
Physical		
Sensory processing disorder/difficulties	25	9.3
Hearing impairments	13	4.9
Visual impairments	3	1.1

Diagnosis	*n*	*%*
Dyspraxia	4	1.5
Epilepsy	5	1.9
Tic disorders	4	1.5
Joint conditions	8	3.0
Other physical conditions	2	0.7
Other		
Other cognitive impairments	1	0.4
Metabolic conditions	1	0.4
Awaiting or undergoing assessment	35	13.1
No diagnosis	12	4.5

FASD, foetal alcohol spectrum disorder.

[a] E.g., dyslexia.

[b] RASopathies include Noonan syndrome, neurofibromatosis type 1, and related disorders.

Supplementary Table S3.2 Mean differences in pairwise comparisons of refined factor scores for the k-means three-cluster solution.

Factor	Mean difference (95% CI)		
	Cluster SS-PS	Cluster SS-PU	Cluster PS-PU
Sensory	-1.37 [-1.60, -1.13] ***	-0.93 [-1.19, -0.67] ***	0.43 [0.18, 0.69] ***
Cognitive Demand	-1.17 [-1.40, -0.95] ***	-1.14 [-1.44, -0.84] ***	0.04 [-0.29, 0.36]
Threat to Self	-0.70 [-0.92, -0.48] ***	-1.66 [-1.92, -1.40] ***	-0.96 [-1.25, -0.68] ***
Cross-settings	-1.17 [-1.41, -0.93] ***	-0.12 [-0.41, 0.18]	1.06 [0.81, 1.30] ***
Safety	0.43 [0.18, 0.67] ***	-0.92 [-1.21, -0.63] ***	-1.35 [-1.61, -1.09] ***
States	-0.57 [-0.84, -0.30] ***	-0.25 [-0.57, 0.08]	0.33[0, 0.65] *

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Tukey's method.

* $p < 0.05$; *** $p < 0.001$.

Supplementary Table S3.3 Univariate comparisons of Social Communication Questionnaire scores for the k-means three-cluster solution using refined factor scores.

SCQ domain	Cluster Mean (*SD*)			Welch's *F*	ω^2	95% CI	Post-hoc Summary [a]
	SS (*n* = 107)	PS (*n* = 98)	PU (*n* = 63)				
Social	8.10 (3.74)	5.03 (3.91)	8.27 (4.08)	$F(2, 154) = 19.9^{***}$	0.124	[0.038, 0.226]	1, 3 > 2
Communication	6.72 (2.79)	5.04 (3.08)	6.73 (2.28)	$F(2, 166) = 10.3^{***}$	0.065	[0.008, 0.146]	1, 3 > 2
Repetitive	5.36 (2.03)	3.53 (2.40)	5.59 (2.15)	$F(2, 155) = 21.8^{***}$	0.135	[0.045, 0.238]	1, 3 > 2
Total	22.21 (7.50)	14.77 (8.45)	22.32 (6.78)	$F(2, 162) = 26.8^{***}$	0.162	[0.066, 0.267]	1, 3 > 2

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

*** $p < 0.001$.

[a] Pairwise Games-Howell tests adjusted with Tukey's method.

Supplementary Table S3.4 Mean differences in pairwise comparisons of Social Communication Questionnaire scores for the k-means three-cluster solution using refined factor scores.

SCQ domain	Mean difference (95% *CI*)		
	Cluster SS-PS	Cluster SS-PU	Cluster PS-PU
Social	-3.07 [-4.34, -1.80] ***	0.17 [-1.32, 1.66]	3.24 [1.70, 4.78] ***
Communication	-1.68 [-2.65, -0.703] ***	0.01 [-0.92, 0.94]	1.69 [0.68, 2.69] ***
Repetitive	-1.84 [-2.58, -1.10] ***	0.22 [-0.57, 1.01]	2.06 [1.20, 2.92] ***
Total	-7.44 [-10.1, -4.79] ***	0.10 [-2.55, 2.76]	7.54 [4.68, 10.4] ***

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Tukey's method.

*** p < 0.001.

Supplementary Table S3.5 Mean differences in pairwise comparisons of non-refined factor scores for the k-means three-cluster solution.

Factor	Mean difference (95% *CI*)		
	Cluster SS-PS	Cluster SS-PU	Cluster PS-PU
Sensory	-0.36 [-0.42, -0.31] ***	-0.34 [-0.41, -0.28] ***	0.02 [-0.04, 0.08]
Cognitive Demand	-0.17 [-0.22, -0.12] ***	-0.25 [-0.32, -0.18] ***	-0.08 [-0.15, -0.01] *
Threat to Self	-0.17 [-0.23, -0.11] ***	-0.59 [-0.66, -0.52] ***	-0.42 [-0.49, -0.36] ***
Cross-settings	-0.33 [-0.39, -0.26] ***	-0.16 [-0.24, -0.08] ***	0.17 [0.10, 0.23] ***
Safety	0.13 [0.05, 0.21] ***	-0.17 [-0.26, -0.08] ***	-0.30 [-0.37, -0.22] ***
States	-0.04 [-0.13, 0.05]	-0.20 [-0.31, -0.09] ***	-0.16 [-0.26, -0.06] ***

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Tukey's method.

* p < 0.05; *** p < 0.001.

Supplementary Table S3.6 Existing measures that informed the development of the Emotional Outburst Questionnaire.

Measure name	Measure type	Reliability and validity
-[6]	Semi-structured informant interview	Convergent validity: 0.66-1
-[5]	Informant-report questionnaire	Test-retest reliability: 0.52-0.76
Multidimensional Assessment of Preschool Disruptive Behavior – Temper Loss scale[2,8]	Informant-report questionnaire	Internal consistency: 0.97 Test-retest reliability: 0.80
Irritability Inventory[9]	Informant-report questionnaire	-
Temper Tantrum Grid[10]	Observational tool	-
-[11]	Observations	-
Autism spectrum disorder – behavior problems for children[12]	Informant-report questionnaire	Inter-informant reliability: 0.49 Test-retest reliability: 0.63 Internal consistency: 0.90
Contextual Assessment Inventory[13]	Informant-report questionnaire	Inter-informant reliability: 0.28 Test-retest reliability: 0.61-0.74 Internal consistency: 0.95
Modified Overt Aggression Scale[14]	Informant-report questionnaire	Inter-informant reliability: 0.85-0.94 Test-retest reliability: 0.72

Supplementary Table S3.7 Features of contextual items in the Emotional Outburst Questionnaire.

Characteristic	Description	Number of items	Example item
Setting events	Environmental factors that increase the likelihood of emotional outbursts.	19	A place that makes them feel safe.
Antecedents	Events that directly trigger emotional outbursts.	36	Change in own routine.

Supplementary Table S3.8 Diagnostic information of individuals whose caregivers contributed to the development of the Emotional Outburst Questionnaire.

Diagnosis	*n*
Intellectual disability	10
ASD	16
ADHD	4
FASD	2
Genetic disorders	3
Under diagnostic assessment	4

ASD, autism spectrum disorder; ADHD, attention deficit hyperactive disorder; FASD, foetal alcohol spectrum disorder.

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CHAPTER 4

CROSS-CULTURAL COMPARISON OF THE CONTEXTS ASSOCIATED WITH EMOTIONAL OUTBURSTS

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The data and computer code used to generate the results are publicly available at https://osf.io/6pvea/.

Abstract

The causal relationship between emotional outbursts and emotion dysregulation is proposed to be heterogeneous, but cultural influences have not been considered despite established cultural differences in emotional processes (e.g., increased motivation to suppress emotions in interdependent cultures). Responses to the Brazilian Portuguese version of the Emotional Outburst Questionnaire were collected from 327 caregivers of young people (6-25 years) with autism spectrum disorder, Down's syndrome, or intellectual disability. Responses were compared to a previous sample of 268 responses from the English version of the questionnaire. The latent factor structure of the contextual items was measurement invariant across both versions. The Brazilian responses were classified into three distinct clusters (Sensory Sensitivity; Perceived Safety; Perceived Unsafety) which considerably overlapped with the English clusters.

Introduction

Background

Emotional outbursts (also known as “temper outbursts”) are one of the most common forms of challenging behaviours in people with autism spectrum disorder (ASD) and other neurodevelopmental disorders, with the potential to cause a wide range of negative impacts on the quality of life of people experiencing outbursts and their families (Acker et al., 2018; Lowe et al., 2007; Lowe & Felce, 1995; Montaque et al., 2018; Myrbakk & Tetzchner, 2008; Ryan, 2010). Previous studies have revealed large variability in terms of the contexts associated with outbursts, which comprise of discrete events with the potential to directly trigger outbursts (antecedents) and background factors that may increase the likelihood for individuals to experience outbursts (setting events; Beauchamp-Châtel et al., 2019; Cressey et al., 2019; Rice et al., 2018; Tunnicliffe et al., 2014).

Emotional outbursts are commonly attributed to a person’s underlying difficulties with emotion regulation or expression (i.e., emotion dysregulation). For example, the experience of emotional outbursts constitutes one item within the Emotion Dysregulation Inventory, which has been specifically developed for measuring dysregulation in individuals with ASD (Mazefsky et al., 2018). However, this one-to-one correspondence appears to be an oversimplification of the link between emotion dysregulation and outbursts, as the interactions between processes such as cognitive, social, and environmental influences contribute to a high degree of heterogeneity in both phenomena, a feature which may be similarly reflected in their causal relationship (Acker et al., 2018; Aldao et al., 2015; Astle et al., 2022; Colombo et al., 2020; Tunnicliffe et al., 2014; Tunnicliffe & Oliver, 2011; White et

al., 2014; Woodcock et al., 2011). Therefore, it is possible that the manifestation of emotional outbursts may vary within and across individuals through multiple distinct pathways, owing to the different ways in which people may be emotionally dysregulated. On the basis that the contexts associated with emotion dysregulation and subsequent emotional outbursts are a common source of variability for both phenomena, we propose that people may experience emotional outbursts in specific subsets of contexts due to underlying differences in emotion regulation or expression that may be unique to those contexts.

Whilst the current literature is lacking, a step towards developing an aetiological account of emotional outbursts is to identify any different patterns of contexts in which individuals experience outbursts, which can subsequently shed light on the underlying differences in emotion regulation or expression associated with those contexts. For example, a previous study involving the caregivers of people with Lowe syndrome has reported a distinct absence of emotional outbursts outside of the home, despite frequent endorsement of antecedents that could commonly occur both in and out of the home environment (e.g., change in own routine), which has similarly been observed in some anecdotal reports by caregivers of people with other neurodevelopmental conditions (Cressey et al., 2019). Under our current proposal, this type of context-dependence of emotional outbursts for some people may be the consequence of differences in emotion regulation or expression which are similarly specific to certain contexts, such that these differences may inhibit the manifestation of outbursts outside of the home and/or facilitate the manifestation of outbursts within the home. Following this line of inquiry may be especially informative for the development of

effective interventions for emotional outbursts, as the emotional differences that lead to outbursts within specific contexts can be more directly targeted.

The aetiological framework of emotional outbursts

Towards the goal of identifying the different patterns of contexts associated with outbursts that may be aetiologically relevant, an exploratory study developed the Emotional Outburst Questionnaire and collected responses from caregivers of children and young people (Chung et al., 2022). The development of this new measure was argued as necessary for advancing our understanding of emotional outburst aetiology, as other existing measures collect limited information regarding outbursts (e.g., frequency of outbursts in the Developmental Behaviour Checklist; Einfeld & Tonge, 1995), or were developed for typically developing individuals (e.g., the Multidimensional Assessment of Preschool Disruptive Behavior; Wakschlag et al., 2012, 2014). Using the Emotional Outburst Questionnaire, it was found that the majority of antecedents and setting events of emotional outbursts could be organised into six latent factors (Chung et al., 2022). These factors were labelled as 1) Sensory, which included sensory stimuli (e.g., sudden or loud noises); 2) Cognitive Demand, which contained antecedents that may be cognitively demanding for an individual (e.g., change in expectation); 3) Threat to Self, which consisted of antecedents that may threaten the self-esteem of an individual (e.g., being criticised); 4) Cross-settings, which contained a range of setting events (e.g., public setting, or unfamiliar person); 5) Safety, which included setting events perceived as safe (e.g., private setting); 6) States, which consisted of setting events related to the physiological state of the individual (e.g., tired).

Based on these contextual factors, responses were transdiagnostically classified into three unique clusters, such that people who experienced outbursts in a similar pattern of contexts were grouped together. These three clusters were proposed to each represent an aetiological pathway to emotional outbursts: 1) children and young people with differences in sensory processing may be more susceptible to experience outbursts across antecedents and setting events due to the additional demand of background stimuli (the Sensory Sensitivity pathway); 2) children and young people who mask their distress in settings that lack perceived safety may experience more outbursts upon returning to safe setting events due to the build-up of distress and the cost of masking (the Perceived Safety pathway); 3) children and young people with differences in safety perception may consider more environments to lack perceived safety, thereby increasing the likelihood for outbursts to be experienced in these unsafe setting events (the Perceived Unsafety Pathway; Chung et al., 2022). As this framework of contextual pathways was derived from exploratory and inductive analysis, the validity and replicability of this proposal remain untested. Therefore, the potential generalisability of the previous interpretations requires evaluation through confirmatory analysis with additional data.

The impact of culture on emotion regulation and emotional outbursts

The need for additional sampling presents a further opportunity to explore the potential influence of culture on the aetiology of emotional outbursts, as the pathways proposed in the previous study were largely constrained to the context of English-speaking caregivers from the United Kingdom. Cross-cultural studies have commonly investigated the differences in emotional processes between societies that promote the independence of the

self from others (e.g., the UK) versus societies that prioritise the interdependence of the self with others (e.g., Brazil; Markus & Kitayama, 1991, 2010). These studies have revealed differing cultural norms in the regulation and expression of emotions (for reviews, see Ford & Mauss, 2015; Friedlmeier et al., 2014), which may lead to fundamental differences in the manifestation and experience of emotional outbursts in individuals across cultures. For example, it has been demonstrated that people from relatively interdependent cultures were more likely to suppress emotions compared to people from relatively independent cultures, a tendency which was motivated by the desire to maintain harmony across interpersonal relationships (Matsumoto et al., 2008; Ramzan & Amjad, 2017). Indeed, this degree of interdependence is apparent in countries such as Brazil, as Brazilian families tend to avoid conflict and place particular emphasis on pleasing family, friends, and the wider community (Dessen & Torres, 2019). Thus, it is possible that individuals from relatively interdependent cultures such as Brazil may be more likely to suppress their distress in response to antecedents, especially within contexts that involve other people (e.g., in public), thereby increasing the likelihood of emotional outbursts manifesting via the Perceived Safety pathway. Additionally, families of individuals with ASD in Brazil have reported a lack of support to socially integrate individuals with ASD into the wider community; and inadequate measures to minimise the exposure to intimidating environments for individuals with ASD (Gomes et al., 2015; Weissheimer et al., 2021). Consequently, these two factors may contribute to the lack of perceived safety in contexts involving the wider community (Dammeyer & Chapman, 2018), further contributing to the experience of distress in these environments.

In addition to cultural differences in how individuals respond to antecedents, there may be further cultural differences in the caregivers' response that can further modulate the likelihood of emotional outbursts in different contexts. For example, cultural differences in the beliefs around the acceptability of expressing negative emotions appeared to influence how caregivers from Brazil and other countries preferred to respond in situations that elicited such emotions in their children (Corapci et al., 2018; Mograbi et al., 2018; Rimes & Chalder, 2010). Cultural differences in the experience of stigma for caregivers of individuals with ASD and other neurodevelopmental disorders may further influence caregiver response to negative emotion expression (Kinnear et al., 2016). For example, a pioneering study covering a large sample of caregivers of people with ASD across Latin America reported that Brazilian caregivers experienced significantly more stigma compared to caregivers from other Latin American countries, which could be related to the greater frustration Brazilian caregivers experienced when seeking support and the lower verbal ability of people with ASD in the Brazilian sample (Paula et al., 2020). Therefore, caregiver response to emotional outbursts may be differentiated by cultural variations in beliefs around negative emotion expression and the experience of stigma, which may include context-specific differences in the caregiver response (e.g., at home versus in public) that can conceivably promote or suppress the experience of emotional outbursts by individuals in different contexts.

As such, the consideration of culture is critical for the proposed framework, as culture itself could be deemed as an overarching level of context that may directly influence how setting events and antecedents may be organised into latent factors, and how these factors may in turn relate to the aetiology of emotional outbursts (Bronfenbrenner & Morris, 2006). There may be fundamental differences in the pathways that emerge from the responses of a

culturally distinct sample, in terms of the distinguishing contexts and mechanisms associated with the identified pathways, and the demographic composition of each group. If a pathway were indeed found to be invariant across cultures, this would demonstrate the importance of recognising the significance of the associated contexts when considering the mechanisms underlying current and potential interventions for emotional outbursts. From a measurement perspective, it would be critical to assess the cross-cultural invariance of the measured constructs related to emotional outbursts, as this would inform the potential generalisability of the derived framework. Furthermore, recent work suggested that measures of emotion regulation strategies were largely invariant across samples of adults from the US and India (Van Doren et al., 2021). If a similar degree of invariance were found across cultures for measures of emotional outbursts, this could facilitate future endeavours in expanding the present framework by integrating patterns of emotional regulation strategies in this cross-cultural aetiological account of emotional outbursts.

The present study aimed to investigate whether the contextual clusters of emotional outbursts that emerge from a culturally distinct sample of caregivers in Brazil would be comparable to the previously identified clusters. To facilitate this cross-cultural comparison, the Emotional Outburst Questionnaire was translated and culturally adapted into a Brazilian Portuguese version, and the factor structure of the contextual items in the Brazilian Portuguese version of the questionnaire was validated and compared against the factors derived from the English version.

Methods

Participants

Caregivers of young people (aged 6-25 years) who experienced emotional outbursts at least once a month were recruited via local autism units for families of children and young people with neurodevelopmental conditions in Brazil. In addition to these units, the questionnaire was also available on social networks of the authors MCTVT and RL for recruitment of eligible caregivers. The age and outburst frequency inclusion criteria matched those of the previous English study (Chung et al., 2022). Out of a total of 359 completed responses, one participant was excluded as the young person was outside the age inclusion criterion. To ensure that the final sample met the criterion for outburst frequency, 27 participants were excluded based on their response to the question regarding general outburst frequency (item 57) on the Emotional Outburst Questionnaire: 20 indicated Less *than once a month*; six selected *Never*; one response was missing. Four participants were excluded as their responses were partially missing for items regarding the antecedents and setting events of emotional outbursts (items 58-112).

Out of the final sample of 327 responses, 250 young people were male (76.5%) and 77 were female (23.5%). The mean age of the young people in the sample was 10.7 years (*SD* = 3.7; range = 6.0–25.7; Supplementary Figure S4.1). Caregivers provided information regarding diagnoses of ASD, Down's syndrome, and/or intellectual disability in a multiple-choice question format. Information regarding other diagnoses was not collected. Across the sample, 252 caregivers selected only ASD (77.1%); 37 selected only Down's syndrome (11.3%); 11 selected only intellectual disability (3.4%); eight selected ASD and Down's

syndrome (2.4%); 12 selected ASD and intellectual disability (3.7%); six selected Down's syndrome and intellectual disability (1.8%); no diagnosis was selected by one caregiver (0.3%). Therefore in total, 272 young people had a diagnosis of ASD (83.2%); 51 individuals were diagnosed with Down's syndrome (15.6%); 29 young people had an intellectual disability (8.9%).

Caregivers of 107 young people indicated that medication was taken for emotional outbursts (32.7%). Fifty-four families have accessed support for outbursts in terms of a programme, intervention, or training (16.5%), 48 of whom found the support to be effective (88.9%). Of the families who have accessed support, 10 received this support immediately or soon after difficulties with outbursts began (18.5%), whilst the 44 remaining families received support a while after (81.5%). With regards to schooling or employment status, 262 young people were in mainstream schools (80.1%); 51 attended special schools (15.6%); one was in further education (0.3%); one was in higher education (0.3%); four were in employment preparation (1.2%); seven were unemployed (2.1%; one missing). Overall, 194 young people received a statement of special educational needs or have an educational plan at school (59.3%). Twenty-five caregivers reported that the young people they were caring for have experienced early traumatic or adverse events (7.6%; four selected *Prefer not to say*; 11 missing), which were described to encompass: natural disasters; death or serious injury of someone close to the person; poverty; witnessing abuse or violence; emotional, physical, or sexual abuse; neglect. Supplementary Table S4.1 compares the demographic information between caregivers from the English (Chung et al., 2022) and Brazilian samples. Differences were present across demographic variables. Compared to the English sample, the Brazilian sample had: a lower mean age; a higher proportion of boys; a higher proportion of diagnoses

of ASD and Down's syndrome; a lower proportion of diagnosis of intellectual disability; a higher proportion of pharmacological intervention use for outbursts; a lower proportion of non-pharmacological intervention use for outbursts; differences in schooling and employment status; and a lower proportion of exposure to trauma.

Measures

The Emotional Outburst Questionnaire is an informant-report measure, which contains 133 items pertaining to the characteristics of outbursts, including the antecedents and setting events associated with outbursts, in addition to frequency, duration, intensity, and behaviours observed in the most and least severe outbursts (Chung et al., 2022). The 55 items related to the antecedents and setting events of outbursts were rated on a three-point scale: *Not applicable/never/rarely (0-3 times out of 10)*, *Sometimes (4-6 times out of 10)*, *Often/always (7-10 times out of 10)*. In the English study, most contextual items loaded onto six latent factors, with internal consistency as indicated by Cronbach's α ranging from 0.68 to 0.84 (Chung et al., 2022).

The translation and cross-cultural adaptation of the Brazilian Portuguese Emotional Outburst Questionnaire was carried out in a previous study (Balbueno, 2021), following the stages recommended by the International Test Commission (2017). The process included: 1) independent translations by two native speakers of Brazilian Portuguese with proficiency in English; 2) synthesis of the two translations and analysis of the synthesis by three experts (two native speakers of Brazilian Portuguese and one native speaker of English) that compared the synthesis with the original versions of the translations using recommendations of the International Test Commission (2017); 3) analysis by the

participants of the target audience based on the understanding of the items, clarity and accuracy; 4) back-translation by a native English speaker and final modifications to rectify discrepancies between the original and back-translated versions of the measure (Balbueno, 2021).

Procedure

Caregivers provided informed consent prior to participating in this study. The majority of participants completed the Brazilian Portuguese version of the Emotional Outburst Questionnaire online on the Research Electronic Data Capture (REDCap) platform (Harris et al., 2009, 2019). Twenty responses were collected in person from caregivers attending a local mental health care centre. Questionnaire and demographic data for the 268 responses to the English version of the questionnaire were accessed via the publicly available repository: https://osf.io/2j47e/.

Statistical analyses

Confirmatory factor analysis

The validity of the factor structure of the contextual items derived from the English data was evaluated with confirmatory factor analysis in the present sample. The factor structure of the base model consisted of items with factor loadings ≥ 0.40 in the previous exploratory factor analysis (Supplementary Figure S4.2; Chung et al., 2022). A series of confirmatory models was estimated using the diagonally weighted least squares method with delta parametrisation in R 4.0.2 (R Core Team, 2021) with the lavaan package (Rosseel, 2012). Model fit was determined by evaluating multiple measures: chi-square statistic, comparative fit index (CFI), root-mean-square error of approximation (RMSEA) and its 90% confidence

intervals (CI), and standardised root-mean-square residual (SRMR). Good model fit is indicated by non-significant chi-square statistic, CFI > 0.95, RMSEA < 0.06, and SRMR < 0.08 (Hu & Bentler, 1999). However, the chi-square statistic is sensitive to sample size, such that chi-square tests with larger samples are more likely to be significant (Schermelleh-Engel et al., 2003). Acceptable model fit is indicated by CFI > 0.90, RMSEA < 0.08, and SRMR < 0.10 (Kline, 2016; van de Schoot et al., 2012). After each model was fitted, modification indices were examined to identify changes to model specification that may improve model fit (Kline, 2016). Each model subsequent to the base model included the addition of a modification which was theoretically relevant and expected to have a high impact on model fit. Internal consistency for each factor in the final model is reported in terms of Cronbach's α. Consistent with the analysis of the previous English study, refined and non-refined factor scores were calculated according to the final confirmatory factor model for each participant for subsequent cluster analyses (Chung et al., 2022). Standardised regression-based factor scores, which accounted for factor loadings and intercorrelations, represented the refined factor scores. In contrast, non-refined factor scores involved taking an unweighted average of the responses to items loading onto each factor.

Measurement invariance analysis

Following identification of the final model, the responses collected with the Brazilian Portuguese version of the Emotional Outburst Questionnaire were compared to those collected with the English version in a multiple-group confirmatory factor analysis to evaluate measurement invariance of the items involved in this factor structure. Establishing measurement invariance across the two groups would allow for between-group comparisons

of contextual items and factors. As per the considerations for measurement invariance in ordered categorical items by Wu and Estabrook (2016), the degree of measurement invariance was evaluated through a series of models with increasing equality constraints across the two groups: 1) configural invariance was tested by fitting both groups to an identical factor structure; 2) threshold invariance included constraining the thresholds for response categories of each item to be equal across the two groups, in addition to specifying an identical factor structure; 3) loading invariance consisted of constraining factor loadings to be equivalent across the two groups, in addition to the constraints of the threshold invariance model. Measurement invariance models were fitted using the diagonally weighted least squares estimator with delta parametrisation, in accordance with the procedures outlined by Svetina et al. (2020), using R packages lavaan (Rosseel, 2012) and semTools (Jorgensen et al., 2021). The changes in model fit indices across models were evaluated to assess measurement invariance. Threshold invariance and loading invariance are indicated by changes in SRMR (ΔSRMR) that are less than 0.010 and 0.030, respectively, in addition to $\Delta CFI < -0.010$ and $\Delta RMSEA < 0.015$ (Chen, 2007).

Cluster analysis of Brazilian refined factor scores

The refined factor scores for the responses from caregivers in Brazil were used to explore patterns of contexts in which outbursts occurred through cluster analyses. The procedure of the previous English study was followed to identify clusters with a data-driven approach, such that the process was independent of the previous outcomes (Chung et al., 2022). The refined factor scores of caregivers in Brazil first underwent hierarchical agglomerative clustering (Ward, 1963), in which three clusters were identified as an appropriate cluster

structure with interpretable clusters. Subsequently, the refined factor scores were analysed with *k*-means clustering with $k = 3$, which allowed for the mean factor scores of each cluster (centroid) to be specified and compared. Classification agreement between hierarchical and *k*-means clustering was achieved for 247 responses (75.5%; Cohen's unweighted $\kappa = 0.64$, 95% CI [0.57, 0.71]). The mean scores of the contextual factors were compared between clusters in a multivariate analysis of variance (MANOVA), followed by separate univariate Welch's ANOVA and post-hoc pairwise Games-Howell tests. Demographic variables with sufficient data were compared between clusters with χ^2 tests of association and ANOVA.

Cross-cultural comparison of Brazilian and English clusters

To identify cross-cultural similarities and differences in the clusters between the two samples, the mean factor scores of each cluster derived from the Brazilian sample were compared to the previously reported mean factor scores of the corresponding cluster from the English sample using Welch's t-tests.

Cluster analysis of Brazilian non-refined factor scores

Non-refined factor scores of Brazilian responses were subject to *k*-means cluster analysis to examine whether these simplified factor scores could produce similar results to those derived from refined factor scores. Establishing invariance in cluster membership across refined and non-refined factor scores would suggest that non-refined factor scores could be used for the clustering of future responses. The use of non-refined factor scores would be preferable over refined scores, as non-refined scores could be calculated for subsequent samples without the requirement of additional factor analysis. When the cluster structures derived from *k*-means clustering of refined factor scores and *k*-means clustering of non-

refined factor scores were compared, cluster membership was retained for 272 responses (83.2%; Cohen's unweighted $\kappa = 0.74$, 95% CI [0.68, 0.80]). As with the analyses conducted for refined factor scores, the mean non-refined factor scores were compared via MANOVA, Welch's ANOVA, and Games-Howell tests.

Cross-cultural comparison of methods of cluster classification

A final set of analyses was performed to evaluate whether the mean scores of non-refined clusters reported in the English study could be utilised as a point of reference to reliably classify the Brazilian responses into these established clusters. If this were demonstrated to be the case, it would support the notion that these cluster centroids may be sample invariant, such that new responses could be classified into these clusters without the need to perform further cluster analysis, thereby allowing for the use of the measure as a screening tool for small numbers of responses. To achieve this goal, the cluster structure based on the non-refined factor scores of the Brazilian responses was compared to classification of the Brazilian responses using cluster centroids of non-refined factor scores from the English study. In the latter procedure, each response from the Brazilian sample was assigned to one of the clusters from the English study with the nearest centroid in terms of Euclidean distance. Classification agreement between these two methods represented a measure of the ability for the cluster centroids established in the English study to classify new responses.

Results

Validation of English contextual factors in the Brazilian Portuguese Emotional Outburst Questionnaire

The six-factor solution from the previous analyses (Supplementary Figure S4.2) was fitted onto the Brazilian responses, which resulted in inadequate model fit based on the chi-square statistic, RMSEA, and SRMR, but acceptable fit based on the CFI (χ^2 [512] = 2444.080, $p < 0.001$; CFI = 0.930; RMSEA = 0.108, 90% CI [0.103, 0.112]; SRMR = 0.119). The modification indices of this base model identified that the addition of the item 'Familiar person' loading onto the Safety factor would improve model fit by the greatest amount. With the addition of this loading, the model demonstrated similar levels of fit as the base model (χ^2 [511] = 2028.165, $p < 0.001$; CFI = 0.945; RMSEA = 0.095, 90% CI [0.091, 0.100]; SRMR = 0.110). An examination of the modification indices for this model indicated that 'Familiar setting' additionally loading onto the Safety factor would further improve model fit. Indeed, addition of this loading improved model fit as indicated by the CFI, RMSEA, and SRMR to levels ranging from acceptable to good (χ^2 [510] = 1523.689, $p < 0.001$; CFI = 0.963; RMSEA = 0.078, 90% CI [0.074, 0.083]; SRMR = 0.100). Therefore, the final model differed from the base model in terms of the additional loading of two items ('Familiar person' and 'Familiar setting') onto the Safety factor (Supplementary Figure S4.3). The internal consistency of each factor, as measured by Cronbach's α was found to be similar to the previous analyses (Sensory = 0.76; Cognitive Demand = 0.81; Threat to Self = 0.82; Cross-settings = 0.80; Safety = 0.85; States = 0.84).

Measurement invariance across the English and Brazilian Portuguese Emotional Outburst Questionnaire

When the responses from the English (*N* = 268) and Brazilian Portuguese (*N* = 327) versions of the questionnaire were combined and fitted onto the final model, the CFI, RMSEA, and SRMR indicated acceptable to good fit (χ^2 [1020] = 2636.512, $p < 0.001$; CFI = 0.959; RMSEA = 0.073, [0.070, 0.077]; SRMR = 0.098), demonstrating configural invariance across the two versions of the questionnaire. As each contextual item comprised of three response options, the threshold invariance model demonstrated no change in fit indices, because the configural invariance and threshold invariance models were statistically equivalent under this condition (Wu & Estabrook, 2016). The fit of the loading invariance model was found to be similar to the previous model (χ^2 [1050] = 2786.788, $p < 0.001$; CFI = 0.956; RMSEA = 0.075, [0.071, 0.078]; SRMR = 0.099), such that the changes in the fit indices across the models suggested that loading invariance was demonstrated across the two versions of the questionnaire (ΔCFI = 0.003; ΔRMSEA = 0.002; ΔSRMR = 0.001). Taken together, the measurement invariance analysis indicated that the information regarding the contexts of outbursts captured by the two versions of the questionnaire could be represented by an identical factor structure with the same set of factor loadings.

Contextual clusters of the Brazilian responses

Refined factor scores

The refined factor scores of the responses based on the Brazilian Portuguese questionnaire were clustered into three groups. The clusters closely resembled those derived from the previous English study (see below), and were therefore accordingly labelled as the Sensory

Sensitivity, Perceived Safety, and Perceived Unsafety clusters. There was a significant difference in the mean refined factor scores between the clusters (Pillai Trace = 0.597, $F(6, 320) = 79.019$, $p < 0.001$, $\omega^2 = 0.589$, 95% CI [0.508, 0.648]), and the univariate tests revealed that there were significant differences between the clusters in the mean scores across all six factors (Table 4.1). All but one of the pairwise comparisons of the mean factor scores were significantly different (Figure 4.1; Supplementary Table S4.2). In the Sensory Sensitivity cluster, the mean scores were relatively high across the factors. The mean scores of the Threat to Self and Safety factors were highest in the Perceived Safety cluster. The mean scores of the Perceived Unsafety cluster were relatively low across factors, but the Sensory and Cross-settings scores for this cluster appeared to be moderately high.

Table 4.1 Cluster centroids of the three-cluster solution derived from Brazilian refined factor scores.

Factor	Cluster Mean (*SD*)			Welch's *F*	ω^2	95% CI	Post-hoc summary [a]
	SS (*n* = 139)	PS (*n* = 94)	PU (*n* = 94)				
Sensory	0.70 (0.58)	-0.80 (0.61)	-0.20 (0.58)	$F(2, 199) = 185.4^{***}$	0.530	[0.389, 0.645]	1 > 3 > 2
Cognitive Demand	0.73 (0.61)	-0.33 (0.51)	-0.77 (0.65)	$F(2,202) = 184.6^{***}$	0.529	[0.390, 0.643]	1 > 2 > 3
Threat to Self	0.22 (0.80)	0.52 (0.57)	-0.83 (0.69)	$F(2, 209) = 111.4^{***}$	0.403	[0.259, 0.532]	2 > 1 > 3
Cross-settings	0.68 (0.55)	-0.90 (0.55)	-0.12 (0.75)	$F(2, 191) = 231.5^{***}$	0.585	[0.449, 0.692]	1 > 3 > 2
Safety	-0.08 (0.79)	0.72 (0.69)	-0.61 (0.76)	$F(2, 204) = 81.6^{***}$	0.330	[0.187, 0.466]	2 > 1 > 3
States	0.72 (0.50)	-0.64 (0.48)	-0.53 (0.65)	$F(2, 193) = 263.0^{***}$	0.616	[0.486, 0.716]	1 > 2, 3

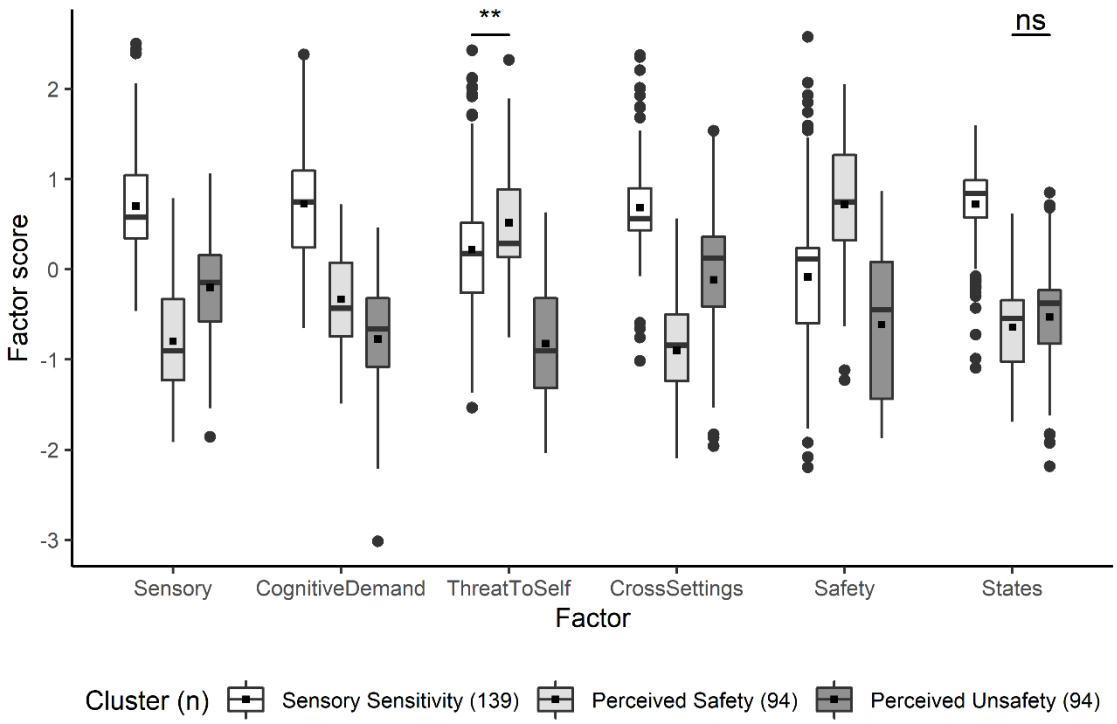
SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Bonferroni correction.

*** $p < 0.001$.

[a] Pairwise Games-Howell tests adjusted with Tukey's method.

Figure 4.1 Pairwise comparisons of the three clusters derived from Brazilian refined factor scores.



Boxplots show mean (black squares) median (horizontal bar), interquartile range (box), range (whiskers) and outliers (circles). All outliers were included in analyses. Unless otherwise specified, all pairwise comparisons within each factor were significant at $p < 0.001$, adjusted with Tukey's method.

Ns not significant; ** $p < 0.01$.

Demographic variables for which sufficient data was available for statistical comparison are presented for each cluster in Table 4.2. There was no significant difference between the

clusters in terms of age, gender, or diagnosis of the young person. Significant differences between the clusters were found in terms of whether the young person received medication for emotional outbursts and whether the family have had access to non-pharmacological support for outbursts. Post-hoc pairwise comparisons revealed that a lower proportion of individuals in the Perceived Safety cluster received medication for outbursts compared to the Sensory Sensitivity cluster (χ^2 (1) = 29.77, p < 0.001, Cramer's V = 0.37, 95% CI [0.23, 0.48], adjusted with Bonferroni correction) and the Perceived Unsafety cluster (χ^2 (1) = 15.70, p < 0.001, Cramer's V = 0.30, 95% CI [0.14, 0.45], adjusted with Bonferroni correction), whereas a higher proportion of individuals in the Perceived Safety cluster have had access to other forms of support for outbursts compared to the Sensory Sensitivity cluster (χ^2 (1) = 8.83, p = 0.009, Cramer's V = 0.21, 95% CI [0.04, 0.36], adjusted with Bonferroni correction).

Table 4.2 Demographics of each of the three clusters derived from Brazilian refined factor scores.

Variable [a]	Cluster			Statistic	Effect size [b]	95% CI
	SS	PS	PU			
N	139	94	94			
Age						
Mean	10.9	10.5	10.4	*F*(2, 324) = 0.64	0.00	[0.00, 1.00]
SD	3.5	4.02	3.68			
Gender (%)				χ^2 (2) = 1.27	0.06	[0.02, 0.19]
Male	77.7	78.7	72.3			
Female	22.3	21.3	27.7			
Diagnosis (%)						
ASD	87.8	80.9	78.7	χ^2 (2) = 3.79	0.11	[0.03, 0.23]
DS	12.9	13.8	21.3	χ^2 (2) = 3.27	0.10	[0.03, 0.23]

Variable [a]	Cluster			Statistic	Effect size [b]	95% CI
	SS	PS	PU			
ID	5.8	13.8	8.5	χ^2 (2) = 4.54	0.12	[0.03, 0.23]
Medication (%)						
Yes	45.3	10.6	36.2	χ^2 (2) = 31.36 ***	0.31	[0.23, 0.40]
Access to support (%)						
Yes	11.5	27.7	12.8	χ^2 (2) = 11.95 **	0.19	[0.08, 0.31]

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety; ASD, autism spectrum disorder; DS, Down's syndrome; ID, intellectual disability.

** $p < 0.01$; *** $p < 0.001$.

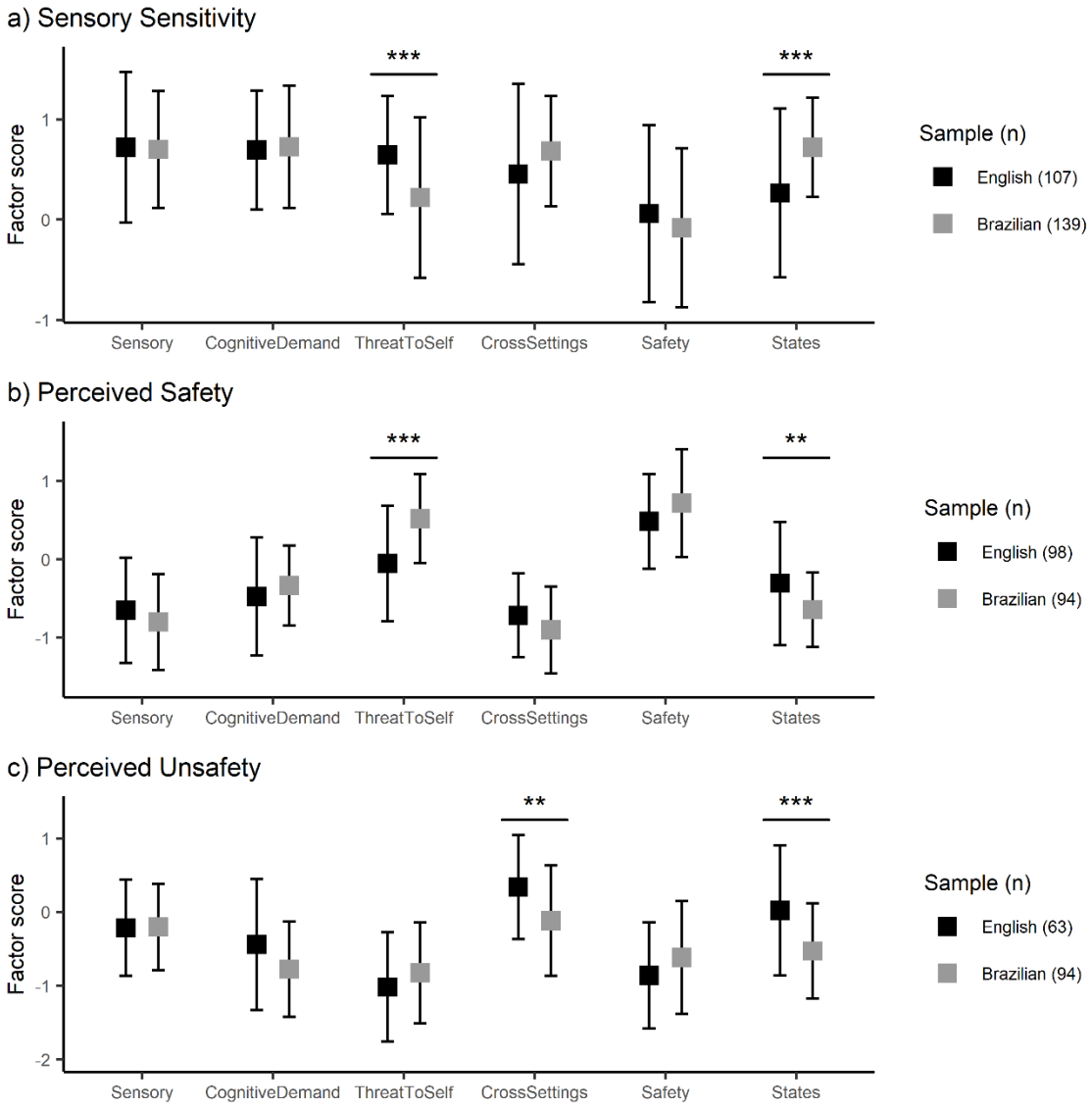
[a] Experience of early traumatic or adverse events could not be reliably compared across clusters due to low endorsement rate.

[b] ω^2 for ANOVA and Cramer's V for χ^2 tests.

The mean factor scores of each cluster from the Brazilian responses were largely comparable to the mean factor scores of the corresponding cluster from the English responses (Figure 4.2). For the Sensory Sensitivity cluster, significant differences between the samples were found in two factors: in the Brazilian sample, the mean Threat to Self score was lower ($t(244) = -4.82$, $p < 0.001$, Cohen's $d = -0.607$, 95% CI [-1.15, -0.20], adjusted with Bonferroni correction) and the mean States score was higher ($t(161) = 4.97$, $p < 0.001$, Cohen's $d = 0.659$, 95% CI [0.26, 1.08], adjusted with Bonferroni correction). The mean Threat to Self and States scores were also significantly different between the samples for the Perceived Safety cluster: in the sample using the Brazilian Portuguese version of the questionnaire, the mean Threat to Self score was higher ($t(182) = 6.01$, $p < 0.001$, Cohen's $d = 0.866$, 95% CI [0.48, 1.27], adjusted with Bonferroni correction) and the States score was lower ($t(161) = -3.61$, p

= 0.007, Cohen's *d* = -0.518, 95% CI [-0.95, -0.06], adjusted with Bonferroni correction). The mean Cross-settings ($t(138) = -3.88$, $p = 0.003$, Cohen's *d* = -0.628, 95% CI [-1.07, -0.18], adjusted with Bonferroni correction) and States scores ($t(106) = -4.24$, $p < 0.001$, Cohen's *d* = -0.711, 95% CI [-1.25, -0.02], adjusted with Bonferroni correction) for the Perceived Unsafety cluster were significantly lower in the Brazilian sample.

Figure 4.2 Centroids of (**a**) the Sensory Sensitivity, (**b**) Perceived Safety, and (**c**) Perceived Unsafety clusters derived from refined factor scores from the samples using the English (black squares) and Brazilian Portuguese (grey squares) versions of the Emotional Outburst Questionnaire.



Error bars represent standard deviations. *p* adjusted with Bonferroni correction across all comparisons.

** $p < 0.01$; *** $p < 0.001$.

Non-refined factor scores

The responses from the caregivers in Brazil were classified into three clusters using non-refined factor scores. A significant difference in the mean factor scores was found between the clusters (Pillai Trace = 0.729, $F(6, 320) = 143.71$, $p < 0.001$, $\omega^2 = 0.724$, 95% CI [0.663, 0.767]). Subsequent univariate (Table 4.3) and pairwise comparisons (Figure 4.3; Supplementary Table S4.3) revealed patterns of differences between the mean non-refined factor scores of the three clusters that were similar to the patterns identified in the clusters derived from the refined factor scores. The Sensory Sensitivity cluster consisted of relatively high mean scores across factors and the Perceived Safety cluster demonstrated higher mean scores specifically in the Threat to Self and Safety factors. Notably however, the mean Cross-settings factor score of the Perceived Unsafety cluster was relatively low.

The cluster structure derived from the Brazilian non-refined factor scores was compared to classification of the Brazilian responses based on centroids derived from the non-refined factor scores of the English sample to evaluate the utility and generalisability of the cluster centroids. Classification agreement between the clustering methods was poor, as cluster agreement was achieved for 146 of the Brazilian responses (44.6%; Cohen's unweighted κ = 0.24, 95% CI [0.18, 0.30]).

Table 4.3 Cluster centroids of the three-cluster solution derived from Brazilian non-refined factor scores.

Factor	Cluster Mean (*SD*)			Welch's *F*	ω^2	95% CI	Post-hoc summary [a]
	SS (*n* = 136)	PS (*n* = 128)	PU (*n* = 63)				
Sensory	0.31 (0.17)	0.13 (0.15)	0.18 (0.14)	$F(2, 175) = 46.6$ ***	0.218	[0.083, 0.364]	1 > 3 > 2
Cognitive Demand	0.71 (0.17)	0.50 (0.13)	0.39 (0.15)	$F(2, 164) = 101.3$ ***	0.380	[0.218, 0.526]	1 > 2 > 3
Threat to Self	0.48 (0.22)	0.56 (0.16)	0.17 (0.16)	$F(2, 174) = 122.4$ ***	0.426	[0.268, 0.563]	2 > 1 > 3
Cross-settings	0.50 (0.13)	0.33 (0.18)	0.32 (0.20)	$F(2, 149) = 50.8$ ***	0.233	[0.085, 0.392]	1 > 2, 3
Safety	0.44 (0.19)	0.51 (0.16)	0.25 (0.22)	$F(2, 156) = 33.3$ ***	0.165	[0.042, 0.315]	2 > 1 > 3
States	0.95 (0.12)	0.41 (0.18)	0.36 (0.23)	$F(2, 142) = 535.5$ ***	0.766	[0.655, 0.841]	1 > 2, 3

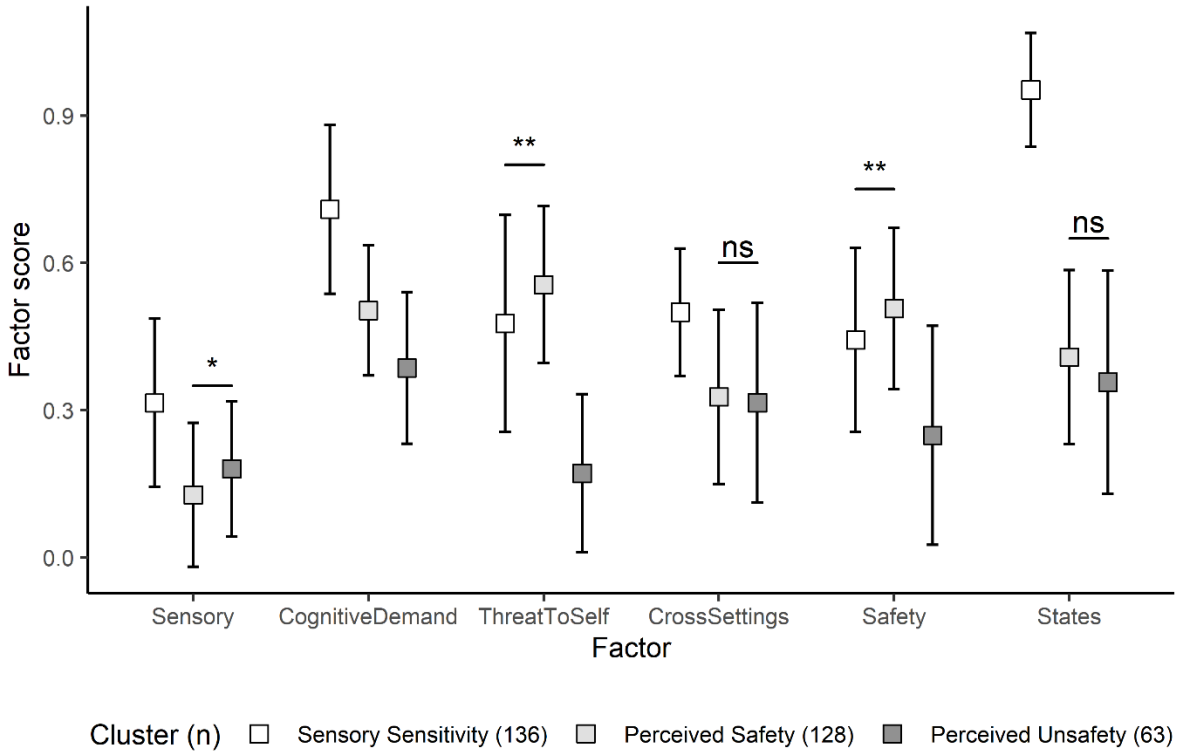
SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Bonferroni correction.

*** $p < 0.001$.

[a] Pairwise Games-Howell tests adjusted with Tukey's method.

Figure 4.3 Pairwise comparisons of the three clusters derived from Brazilian non-refined factor scores.



Cluster centroids are displayed as means (squares), with standard deviations as error bars. Unless otherwise specified, all pairwise comparisons within each factor were significant at $p < 0.001$, adjusted with Tukey's method.

Ns not significant; * $p < 0.05$; ** $p < 0.01$.

Discussion

The present study sought to identify cross-cultural differences in the patterns of contexts associated with emotional outbursts experienced by children and young people with neurodevelopmental disorders in Brazil versus the patterns derived from children and young

people using the English version of the Emotional Outburst Questionnaire. In order to facilitate this goal, a Brazilian Portuguese version of the Emotional Outburst Questionnaire was developed. The contextual items of the Brazilian Portuguese version of the questionnaire could be organised into a latent six-factor solution comparable to that identified in the English version. This new factor structure, which involved two additional loadings, appeared to be measurement invariant across the two versions of the questionnaire, such that the responses from the two samples could be represented by the same factor structure and an equal set of factor loadings. Based on these contextual factors, the Brazilian responses were divided into three clusters with distinct patterns of contexts, which resembled the patterns that had previously been identified using the English version of the questionnaire.

Cultural differences in the Emotional Outburst Questionnaire

The confirmatory analyses from this study contributed to the validation of a variant of the factor structure underlying the contextual items of the Emotional Outburst Questionnaire, which included the additional loadings from items concerning familiar people and settings onto the Safety factor, which originally consisted of items that would more directly contribute to the perceived safety of an environment (e.g., a private setting or a person that the individual liked; Supplementary Figures S4.2 & 4.3). Although these modifications were primarily data-driven, they nevertheless appeared to be theoretically consistent, as individuals may be more likely to perceive familiar contexts as safe (Brosschot et al., 2018). The measurement invariance of the contextual items in the questionnaire provided further evidence regarding the robustness of the measure across samples and across cultures.

Within the field, the ability to compare results across studies of emotional outbursts in people with neurodevelopmental disorders has been limited by the range of approaches that have been used to systematically characterise outbursts in previous studies (e.g., Beauchamp-Châtel et al., 2019; Rice et al., 2018; Tunnicliffe et al., 2014), which has further precluded the consideration of the impact of culture on the aetiology of emotional outbursts. The Emotional Outburst Questionnaire may be able to overcome this barrier and enable direct comparisons across studies utilising the questionnaire and across cultures, but further validation of both the contextual items and the remaining items is warranted.

The development of a culturally sensitive framework of emotional outbursts

The adaptation of the questionnaire into Brazilian Portuguese may facilitate future efforts to investigate emotional outbursts experienced by people in Brazil, a population for whom information regarding outbursts is scarce. Indeed, such endeavours will be critical in refining the aetiological account of emotional outbursts into a culturally sensitive framework, as the majority of the previous literature regarding outbursts has been based on a Western perspective. Cross-cultural comparisons between individuals from additional countries may further reveal the relevance of cultural factors, such as the orientation towards social independence versus interdependence, in the manifestation of emotional outbursts. Furthermore, the inclusion of culturally sensitive measures in these comparisons may simultaneously identify sources of between-group differences and capture within-group variability, which may both be relevant to the observed heterogeneity of emotional outbursts. For example, in regard to cross-cultural comparisons of emotional outbursts between children and young people in Brazil and the UK, it may be beneficial to include the

Beliefs about Emotions Scale (Rimes & Chalder, 2010), as the measure appeared to capture differences between how adults in the UK and Brazil conceptualise the beliefs of the acceptability of negative emotion expression (Mograbi et al., 2018).

The three clusters derived from the refined factor scores of the Brazilian responses appeared to largely resemble the clusters previously identified in the English study, in which the clusters were distinguished by 1) high mean scores across contextual factors; 2) high mean Safety score; and 3) high mean Cross-settings score. The similarities across the samples indicate that these clusters may represent – regardless of the country – cross-cultural pathways that describe the variable aetiology of emotional outbursts, which could form the basis of pathway-specific interventions. Additional cross-cultural validation of the Emotional Outburst Questionnaire may facilitate the use of the questionnaire as a screening tool to support the development and delivery of these interventions by ensuring that the outbursts of individuals are classified in a culturally sensitive manner. Furthermore, future work should assess the replicability of the cluster structure of responses in samples from additional cultures so that the potential generalisability of the present framework could be appraised. If the overall pattern of pathways were indeed found to be cross-culturally consistent, fine-grained cultural differences could nevertheless add a degree of variability to the overall pattern of contexts associated with each pathway (e.g., Caron et al., 2012; Gilbert, 2014; Hull et al., 2020).

Indeed, several differences between the clusters derived from refined factor scores from the two samples were identified in this study. One notable difference was the relatively high mean Threat to Self score for the Perceived Safety cluster in the responses from caregivers in

Brazil. This difference may be related to the motivation for a person to mask their emotions to hide characteristics that may be perceived by others as less socially desirable (e.g., Cook et al., 2021). Therefore, a person who is motivated to maintain a socially desirable impression on others by masking their emotions may also be more likely to react negatively in the form of an emotional outburst if their self-image or self-esteem is threatened. The prominence of the mean Threat to Self score in the Perceived Safety cluster of the Brazil sample appears to be consistent with a cultural perspective, as individuals from Brazil may place more value on how they are perceived by others within their community, and the individuals may also receive more prejudice and stigma from the community that may negatively impact their self-esteem (Dessen & Torres, 2019; Paula et al., 2020).

A second difference was that the mean Cross-settings score for the Perceived Unsafety cluster was not as high in the Brazilian responses compared to that of the corresponding cluster in the responses to the English version of the questionnaire. Given that there is less social integration into the wider community for individuals with ASD in Brazil, contexts associated with low perceived safety may be more widespread, such that the Cross-settings factor of the questionnaire could not adequately capture these contexts in the Brazilian responses (Gomes et al., 2015; Weissheimer et al., 2021). Additionally, it is possible that this difference in mean Cross-settings score stemmed from the subjective nature of safety perception. In support of the importance of the subjectivity of contexts in the manifestation of emotional outbursts, a previous study involving adolescents with ASD from the UK reported that contrary to expectations, one participant regarded unpredictable changes to routines as positive rather than negative (Acker et al., 2018). The authors identified that instead of the unpredictability of situations, the perception of being pressurised or rushed

was more salient to the manifestation of emotional outbursts for the young people in the study (Acker et al., 2018). Therefore, the investigation of safety perception in relation to emotional outbursts may benefit from further qualitative work with young people who experience outbursts to explore the salience and cross-cultural differences of this relationship.

In contrast to the English study, which had found associations of autism spectrum disorder with the Sensory Sensitivity cluster and intellectual disability with the Perceived Unsafety cluster (Chung et al., 2022), no such associations were identified in the responses from caregivers in Brazil. This lack of association between cluster membership and diagnostic status may be due to differences in the composition of diagnoses in the two samples, as the proportion of young people with a diagnosis of autism spectrum disorder was greater in the Brazilian sample than the English sample, whereas the proportion of young people with intellectual disability was lower in the Brazilian sample (Supplementary Table S4.1). Regarding other demographic factors in the present study, young people in the Perceived Safety cluster were observed to be less likely to receive medication for outbursts and more likely to have accessed other forms of social or psychological support. These discrepancies in access to medication and other forms of support may potentially stem from individuals in the Perceived Safety cluster having a higher level of adaptive functioning compared to individuals in other clusters, as the underlying mechanism for the Perceived Safety cluster is hypothesised to involve the suppression of negative emotions outside of safe settings, which may require greater regulatory ability to achieve (Chung et al., 2022) Therefore, young people in the Perceived Safety cluster may be more likely to receive psychological as opposed to pharmacological interventions, as some psychological interventions for

challenging behaviours have been found to be more effective for people with greater adaptive functioning (e.g., mindfulness training; for recent review, see Woodcock & Blackwell, 2020). From a cultural perspective, it is also possible that families are less likely to access medication over other forms of support for emotional outbursts because the impact of the outbursts experienced by young people in the Perceived Safety cluster may be perceived to be lower in the context of a relatively interdependent culture, as these outbursts are mostly experienced in safe settings such as at home or in a private environment, rather than in contexts where unfamiliar community members may be present.

In terms of classification using the non-refined factor scores from the Brazilian responses, the distinguishing features of the centroids for the Sensory Sensitivity and Perceived Safety clusters were maintained, but the mean Cross-settings score for the Perceived Unsafety cluster was not prominent. The use of unweighted non-refined factor scores would be preferable to regression-based refined factor scores, as it would allow new responses to be scored and classified without the prerequisite of conducting factor and cluster analyses, which would be beneficial for studies with smaller samples or those focusing on specific subsets of emotional outbursts. However, the present study demonstrated that this procedure may not be feasible, as the non-refined factor scores calculated for responses from Brazilian caregivers could not be reliably classified into existing clusters from the English study. It is possible that the loss of information from the use of unweighted factor scores hinders reliable classification in this way, so a compromise could potentially be achieved through the use of factor scores weighted by factor loadings (DiStefano et al., 2009). Additionally, there may be inherent cross-cultural variability in the centroids of the

clusters that prevent cross-cultural classification. Therefore, further within- and cross-cultural comparisons should be conducted to investigate whether standardised cluster centroids could be derived either within or across cultures.

Limitations and future directions

The present study was limited by the diagnostic homogeneity of the young people within the sample, which precluded further investigations into potential diagnostic differences in cluster membership. However, the converging evidence between the English study, which included higher heterogeneity in terms of diagnoses of young people, and the current study suggest that the proposed pathways may indeed be transdiagnostic (Chung et al., 2022). Future studies could address this question more directly by using a between-groups design to compare the patterns of outbursts between individuals with different diagnoses. The broader demographic differences between the two samples should be considered and potentially controlled for in subsequent studies, as the potential effects of these demographic differences could not be accounted for in the present study. For example, investigations focusing on the emotional outbursts experienced by young people in the upper age range of the present study may be beneficial, as they were less represented in the present sample. Furthermore, as the Emotional Outburst Questionnaire is an informant-report measure, the potential effect of caregiver educational level on the accuracy of responses should be examined (e.g., Van Roy et al., 2010). A critical avenue for future work lies in assessing the associations between cluster membership and measures of differences in the proposed underlying mechanisms to further delineate the aetiology of emotional outbursts.

Conclusions

This study demonstrated that the contextual items of the Brazilian Portuguese version of the Emotional Outburst Questionnaire could be organised into a latent six-factor structure, which was measurement invariant across the Brazilian Portuguese and English versions of the questionnaire. Three clusters were generated from the responses from caregivers in Brazil, which were found to be comparable to corresponding clusters from a culturally distinct sample in terms of the distinguishing features of each cluster. The present results suggest that these clusters may represent aetiological pathways of emotional outbursts that are both transdiagnostic and cross-cultural.

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Supplementary Information

Supplementary Table S4.1 Comparison of demographic information between caregivers of the English and Brazilian samples.

Variable	Sample		Statistic	Effect size [a]	95% CI
	English	Brazilian			
N	268	327			
Age					
Mean	13.5	10.7	$t(468) = 7.5$ ***	0.626	[0.46, 0.79]
SD	5.2	3.7			
Gender (*n* [%]) [b]			χ^2 (1) = 16.5 ***	0.170	[0.096, 0.251]
Male	162 (60.4)	250 (76.5)			
Female	105 (39.2)	77 (23.5)			
Other	1 (0.4)	0 (0)			
Diagnosis (*n* [%]) [c]					
Autism spectrum disorder	132 (49.3)	272 (83.2)	χ^2 (1) = 76.2 ***	0.362	[0.284, 0.431]
Down's syndrome	4 (1.5)	51 (15.6)	χ^2 (1) = 33.3 ***	0.242	[0.189, 0.294]
Intellectual disability	77 (28.7)	29 (8.9)	χ^2 (1) = 38.3 ***	0.258	[0.181, 0.333]
Medication (*n* [%]) [d]			χ^2 (1) = 2.7	0.071	[0.006, 0.145]
Yes	70 (26.2)	107 (32.7)			
Access to support (*n* [%]) [e]			χ^2 (1) = 71.5 ***	0.351	[0.270, 0.426]
Yes	130 (49.2)	54 (16.5)			
Schooling or employment (*n* [%]) [f]			χ^2 (3) = 51.1 ***	0.298	[0.229, 0.375]
Mainstream school	146 (54.9)	262 (80.1)			
Special school	68 (25.6)	51 (15.6)			
Further education	11 (4.1)	1 (0.3)			
Higher education	2 (0.8)	1 (0.3)			
Employment preparation	4 (1.5)	4 (1.2)			
Employed	5 (1.9)	0 (0)			
Unemployed	30 (11.3)	7 (2.1)			

Variable	Sample		Statistic	Effect size [a]	95% CI
	English	Brazilian			
Statement of special educational needs or educational plan (*n* [%]) [g]			χ^2 (1) = 0.1	0.016	[0.001, 0.102]
Yes	160 (59.7)	194 (59.3)			
Trauma (*n* [%]) [h]			χ^2 (1) = 101 ***	0.474	[0.379, 0.559]
Yes	73 (48.3)	25 (7.6)			

[a] Cohen's *d* for Welch's t-test and Cramer's V for χ^2 tests.

[b] Non-binary response from English sample excluded for χ^2 test.

[c] Proportion of young people with each diagnosis. Each caregiver could indicate more than one diagnosis for the multiple-choice question in the survey.

[d] One response missing in English sample.

[e] Four responses missing in English sample.

[f] Two responses missing in English sample; one response missing in Brazilian sample. Responses indicating *Higher education*, *Employment preparation*, or *Employed* excluded for χ^2 test.

[g] Four responses missing in English sample.

[h] One hundred and seventeen responses missing and four selected *Prefer not to say* in English sample; 11 responses missing and four selected *Prefer not to say* in Brazilian sample. Responses indicating *Prefer not to say* excluded for χ^2 test.

*** $p < 0.001$.

Supplementary Table S4.2 Differences in cluster centroids derived from Brazilian refined factor scores.

Factor	Mean difference (95% CI)		
	SS-PS	SS-PU	PS-PU
Sensory	-1.50 [-1.69, -1.31] ***	-0.90 [-1.09, -0.72] ***	0.59 [0.39, 0.80] ***
Cognitive Demand	-1.06 [-1.23, -0.88] ***	-1.50 [-1.70, -1.30] ***	-0.44 [-0.64, -0.24] ***
Threat to Self	0.30 [0.09, 0.51] **	-1.05 [-1.28, -0.81] ***	-1.34 [-1.56, -1.13] ***
Cross-settings	-1.58 [-1.76, -1.41] ***	-0.80 [-1.01, -0.59] ***	0.78 [0.56, 1.01] ***
Safety	0.80 [0.57, 1.03] ***	-0.53 [-0.78, -0.29] ***	-1.33 [-1.58, -1.08] ***
States	-1.36 [-1.52, -1.21] ***	-1.25 [-1.44, -1.06] ***	0.11 [-0.08, 0.31]

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

p and confidence intervals adjusted with Tukey's method.

** $p < 0.01$; *** $p < 0.001$.

Supplementary Table S4.3 Differences in cluster centroids derived from Brazilian non-refined factor scores.

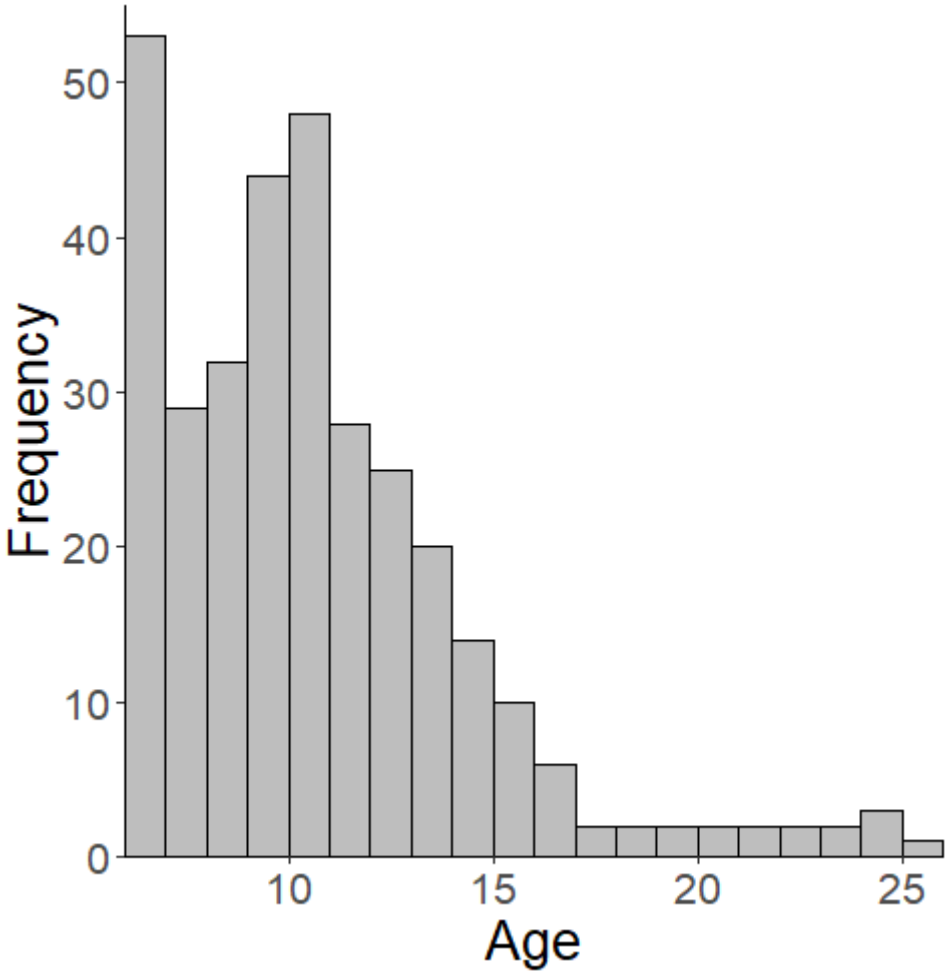
Factor	Mean difference (95% CI)		
	SS-PS	SS-PU	PS-PU
Sensory	-0.19 [-0.23, -0.14] ***	-0.13 [-0.19, -0.08] ***	0.05 [0.00, 0.10] *
Cognitive Demand	-0.21 [-0.25, -0.16] ***	-0.32 [-0.38, -0.27] ***	-0.12 [-0.17, -0.06] ***
Threat to Self	0.08 [0.02, 0.13] **	-0.31 [-0.37, -0.24] ***	-0.38 [-0.44, -0.33] ***
Cross-settings	-0.17 [-0.22, -0.13] ***	-0.18 [-0.25, -0.12] ***	-0.01 [-0.08, 0.06]
Safety	0.06 [0.01, 0.12] **	-0.19 [-0.27, -0.12] ***	-0.26 [-0.33, -0.18] ***
States	-0.54 [-0.59, -0.50] ***	-0.60 [-0.67, -0.52] ***	-0.05 [-0.13, 0.03]

SS, Sensory Sensitivity; PS, Perceived Safety; PU, Perceived Unsafety.

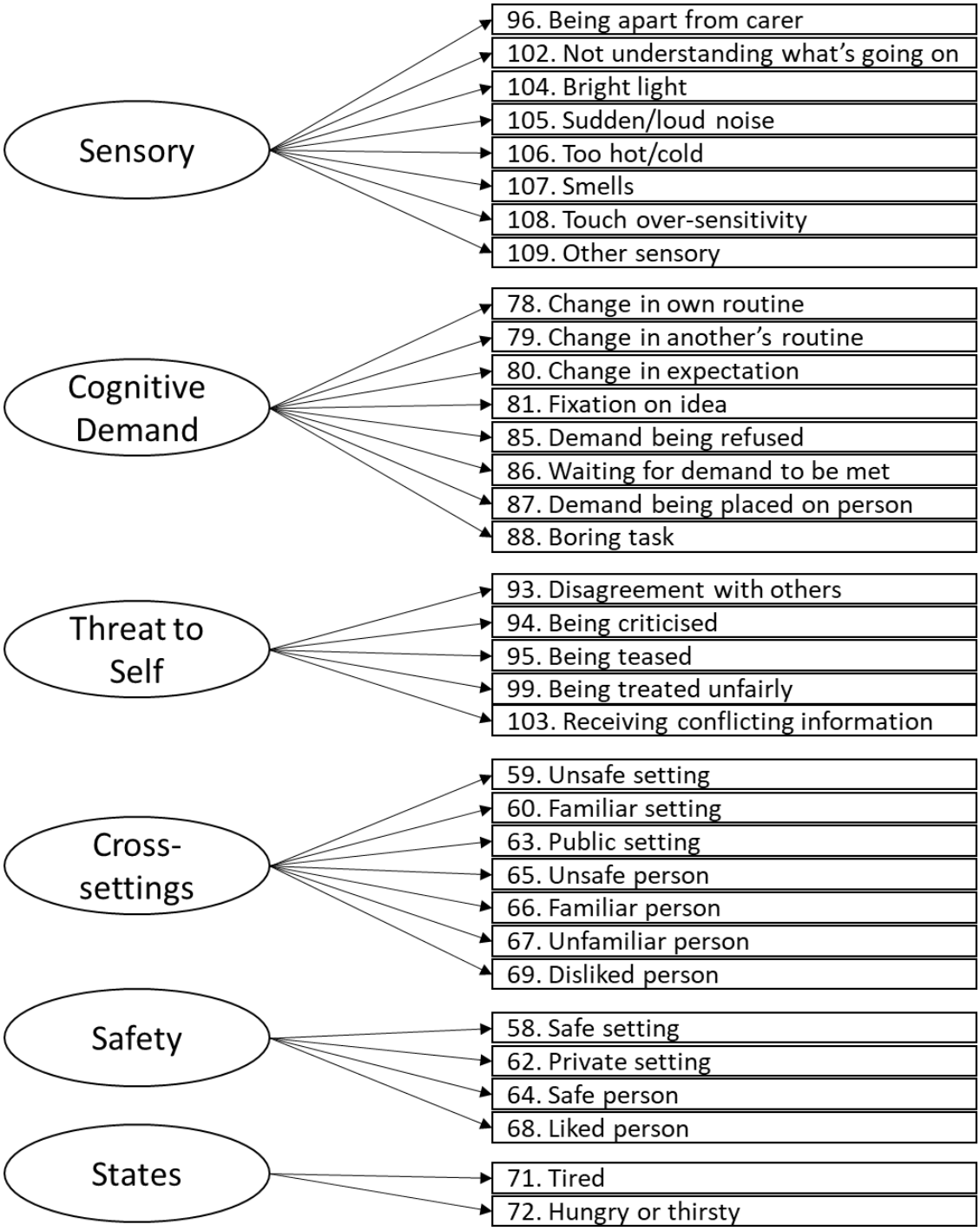
p and confidence intervals adjusted with Tukey's method.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Supplementary Figure S4.1 Age frequency distribution of children and young people in the Brazilian sample.

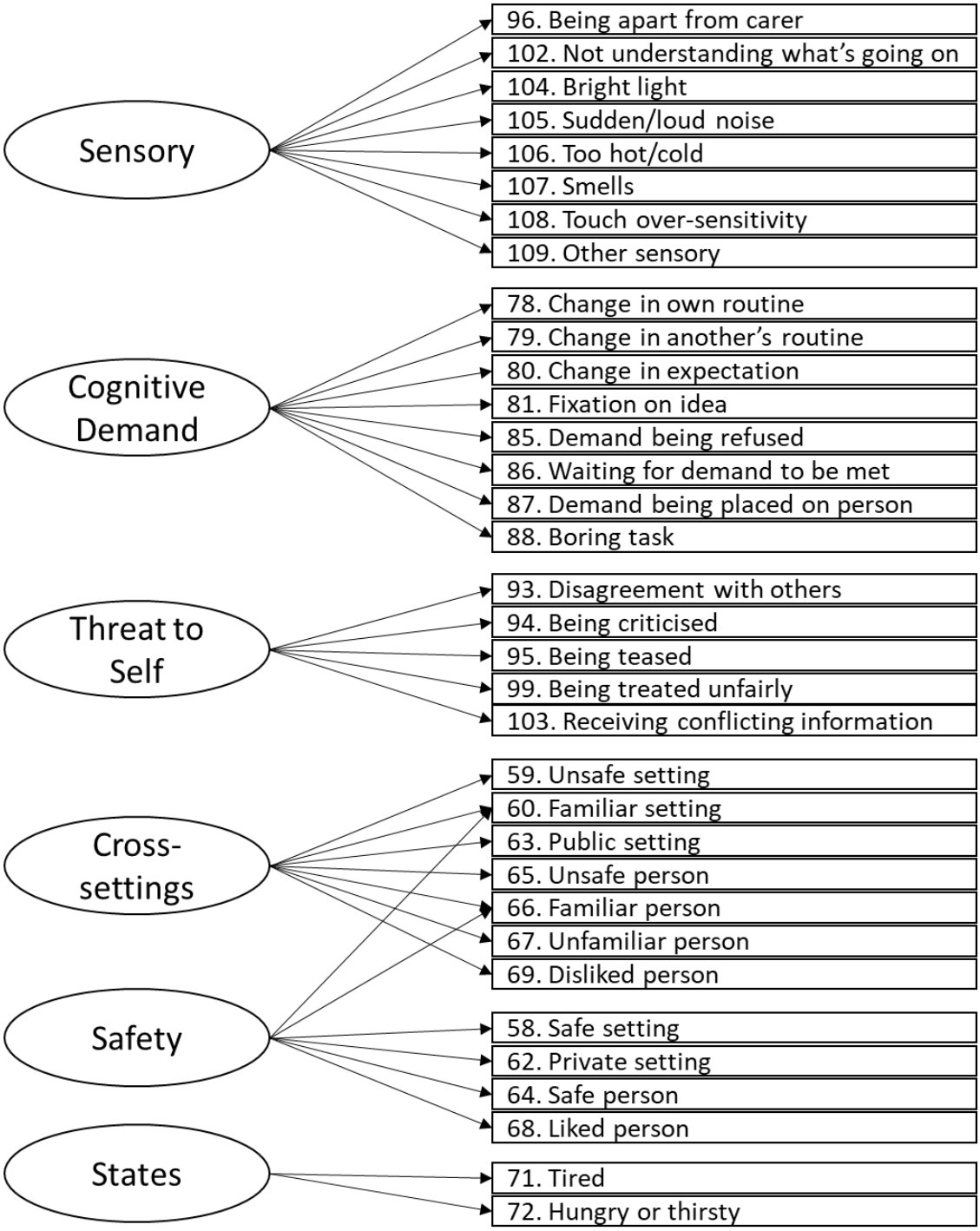


Supplementary Figure S4.2 Six-factor structure of contextual items of the Emotional Outburst Questionnaire based on responses from the previous English study.



Ellipses represent factors; rectangles represent contextual items.

Supplementary Figure S4.3 Revised six-factor structure of contextual items of the Emotional Outburst Questionnaire based on responses from the present study.



Ellipses represent factors; rectangles represent contextual items. Covariances between

factors and variances of each contextual item are not shown in the figure but were estimated by the models specified in the present study.

Acknowledgements

Thank you to the caregivers who took part in the research and the organisations that have helped with recruitment. Data from this article were presented at the Society for the Study of Behavioural Phenotypes International Research Symposium (2021).

CHAPTER 5

"IT'S LIKE SHAKING A BOTTLE OF POP": PERSPECTIVES OF CAREGIVERS ON THE AETIOLOGY OF EMOTIONAL OUTBURSTS IN CHILDREN AND YOUNG PEOPLE

In preparation for submission.

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Abstract

The aetiology of emotional outbursts is proposed to be driven by emotion dysregulation. The pathways through which dysregulation occurs are hypothesised to be dependent on the environmental context, but the theoretical bases for such pathways are limited. Through semi-structured interviews, caregivers of 24 children and young people with neurodevelopmental conditions and three children and young people shared their perspectives on outbursts in contexts associated with proposed pathways. Using a grounded theory approach, three core categories related to outburst aetiology were inductively derived from the data: 1) the chronology of emotional outbursts; 2) the moderating effects of perceived comfort; and 3) the moderating effects of sensory stimuli. The present findings offer insight into the mechanisms involved in outbursts related to sensory stimuli and different levels of perceived comfort. Furthermore, the results provide the basis for future work to characterise other context-specific effects in terms of the escalation and manifestation of outbursts.

Introduction

People with neurodevelopmental conditions and people who have experienced childhood trauma commonly experience emotional outbursts or meltdowns, which negatively affect the wellbeing and quality of life of the people experiencing outbursts and those around them (Green et al., 2010; Lowe et al., 2007; Montaque et al., 2018; S. Ryan, 2010). Whilst there is no consensus on a single definition, emotional outbursts can be broadly described as sudden and emotional episodes of challenging behaviour in response to the environmental context (Carlson et al., 2022; Chung et al., 2022). The contexts associated with outbursts show considerable variability within and across individuals, and are classified in terms of events that directly cause an outburst (antecedents) and the background factors that potentiate the effects of such antecedents (setting events; e.g., Cressey et al., 2019; Rice et al., 2018).

From an aetiological perspective, it is widely assumed that an emotional outburst is the consequence of emotion dysregulation, whereby a person becomes overwhelmed by the environment (Carlson et al., 2022). The link between such dysregulation and emotional outbursts is supported by previous studies on the perspectives of young people and their caregivers, which indicated that young people lose control over their emotion and behaviour during outbursts (Acker et al., 2018; S. Ryan, 2010). Given that both emotional outbursts and emotion dysregulation are highly variable along the common dimension of environmental context, it is likely that the aetiology of outbursts may be represented by a heterogeneous collection of parallel pathways, each relating a specific pattern of differences in emotion regulation to a pattern of contexts in which emotional outbursts occur (Astle et al., 2022;

Chung et al., 2022; Colombo et al., 2020). An example of such a pathway has been demonstrated for change-related outbursts in people with Prader-Willi syndrome, who were more likely to be overwhelmed by environmental changes due to a specific difference in the cognitive ability of task-switching (Woodcock et al., 2009a, 2009b, 2011).

Recent work has further expanded the aetiological framework by identifying three unique patterns of contexts associated with outbursts across a transdiagnostic sample of children and young people (Chung et al., 2022). The three observed patterns indicated that emotional outbursts were more likely to occur: 1) across antecedents and setting events, including sensory stimuli; 2) in setting events perceived to be safe (e.g., at home); and 3) in setting events perceived to not be safe (e.g., in public; Chung et al., 2022). These patterns of outbursts were proposed to each represent the set of contexts within which an aetiological pathway operates. The primary mechanism of each pathway was hypothesised to involve differences in: 1) sensory sensitivity such that background stimuli impose greater demand on a person's ability to regulate across contexts; 2) masking of a person's distress outside of safe contexts, the build-up of which manifests as outbursts in safe contexts; and 3) safety perception such that the perceived lack of safety in certain contexts causes greater distress and contributes to emotion dysregulation (Chung et al., 2022).

This framework seeks to present a platform upon which pathway-specific interventions for emotional outbursts can be developed, but it requires further validation and refinement to ensure that the theoretical basis underlying each pathway is sufficiently robust. The current theoretical bases for the three new pathways are arguably inadequate, as the hypothesised mechanisms were largely based on tangential evidence from the wider field and anecdotal

accounts from caregivers, owing to the scarcity of aetiological studies on outbursts in the extant literature (Chung et al., 2022). Nevertheless, the patterns of contexts associated with the proposed pathways were empirically derived and supported by evidence from previous studies on outbursts, thus providing a robust foundation for further investigation (Acker et al., 2018; Chung et al., 2022; Cressey et al., 2019; Duignan & Connell, 2015; S. Ryan, 2010).

The present study aimed to explore the aetiological processes of emotional outbursts associated with the previously identified patterns of contexts. Caregivers were expected to be especially informative for this goal, as their experiences of outbursts might provide critical insight into the aetiological processes involved. Therefore, the perspectives of caregivers of children and young people with emotional outbursts were collected in this study through semi-structured interviews, which enabled inductive development of the aetiological framework. Whilst the primary aim was to explore the views of caregivers, the results in the present study were supplemented by the perspectives of a small number of children and young people who completed similar interviews.

Methods

Participants

Caregivers were recruited from a database of individuals who had previously taken part in research and indicated an interest in future participation, and from support groups for people with neurodevelopmental conditions in the United Kingdom, United States, and Australia. To be eligible for the study, participants had to be caring for children and young people who experienced outbursts more than once a month and who were aged between 6-25 years. It was indicated to caregivers that whilst they were the primary participants of the

present study, the children and young people whom they care for were welcome to participate in adapted interviews to share their personal experiences of outbursts. Children and young people's participation in the study was optional and dependent on whether the children and young people and/or their caregivers considered the study to be appropriate for their level of ability, understanding, and willingness to discuss potentially distressing topics.

Caregivers of 24 children and young people participated. One caregiver described their experience of outbursts in two children, and three pairs of caregivers participated. Twenty-two caregivers were female and four were male. Two participants were foster carers, and the remaining participants were parents of the children and young people. The demographic information of the children and young people are presented in Table 5.1 and Supplementary Table S5.1. Three children and young people aged between 9-19 years took part in individual interviews.

Table 5.1 Summary demographics of children and young people cared for by the participants

Variable	Statistic
Age	
Mean (*SD*)	12.5 (5.1)
Range	6-24
Gender (*n*)	
Male	15
Female	9
Diagnosis (*n*) [a]	
Anxiety	7
Attachment difficulty/disorder	3
Attention deficit hyperactive disorder	5
Autism spectrum disorder	9

Variable	Statistic
Cornelia deLange syndrome	9
CHARGE syndrome	4
Disruptive behaviour disorder	1
Down's syndrome	3
Dyspraxia	1
Hearing impairment	7
Intellectual disability	12
Sensory processing difficulty/disorder	2
Specific learning difficulty [b]	5
Williams syndrome	1
Schooling or employment (*n*)	
Mainstream school	11
Special school	6
Further education (college)	3
Home education	3
Unemployed	1
Medication for outbursts (*n*)	
Yes	6
Access to non-pharmacological support (*n*)	
Yes	14
Statement of special educational needs or educational plan (*n*)	
Yes	21
Childhood adversity or trauma (*n*)	
Yes	8
Location (*n*)	
United Kingdom	10
North America	10
Other	4

[a] Each caregiver could indicate more than one diagnosis.

[b] E.g., dyslexia.

Materials

Semi-structured interviews

Separate interview schedules for caregivers and young people were developed to guide the progression of interviews (see Appendices 2 and 3). Open-ended questions were used in the interview schedules to allow for exploration of the perspectives of participants, but prompts were used when necessary to obtain additional detail. The interview schedules covered a range of topics related to emotional outbursts, including aetiology, impact, the acceptability and feasibility of experiments involving observations of outbursts, and the effects of the COVID-19 pandemic. Not all listed topics were discussed with each participant and other unlisted but relevant topics were explored to ensure that in keeping with a grounded theory methodology , the interview questions evolved as new data emerged (Charmaz, 2006; Corbin & Strauss, 2015). Prior to data collection, the caregiver interview schedule was piloted with a caregiver of a young person who experienced outbursts but who was ineligible for the study due to the young person's age. This pilot interview was not included in the present analysis. Consistent with a grounded theory approach (Charmaz, 2006; Corbin & Strauss, 2015), the caregiver interview schedule was iteratively updated throughout data collection to ensure that it covered common topics of discussion (e.g., outbursts related to demands) and to explore specific lines of inquiry in further detail (e.g., how a young person's ability to cope or communicate affects outbursts). The present study focused specifically on data relating to the aetiology of outbursts. The section on outburst aetiology primarily involved questions regarding the effects of perceived safety or unsafety of the environment

and sensory stimuli to enable development of the theoretical bases of emotional outbursts in these specific contexts.

Emotional Outburst Questionnaire

The Emotional Outburst Questionnaire is an informant-report measure assessing multiple aspects of outbursts, such as frequency, duration, observed behaviour, antecedents, setting events, and management strategies (Chung et al., 2022). This measure was included as part of a wider aim to assess the convergent validity of the questionnaire and interview responses, but this is not reported in the present study. Contextual factor scores from the questionnaire responses of caregivers in the present sample were not calculated and classified into clusters due to concerns around the validity of classifying new data with cluster centroids of previous samples, as highlighted by the work in Chapter 4, and the current lack of information on how the scores could be interpreted in other meaningful ways.

Procedure

Data collection spanned from May 2020 to April 2021. Caregivers and young people who were interviewed provided informed consent prior to taking part in the study. Online versions of the Emotional Outburst Questionnaire and a demographic questionnaire were completed by caregivers. The first author conducted telephone or online interviews, each spanning between one to three sessions, depending on the availability of caregivers and young people. A reflective diary with an entry for each caregiver interview was kept throughout the data collection process. Interviews were audio-recorded and subsequently transcribed. The duration of interviews ranged from 50 to 117 minutes (mean = 88 minutes)

for caregivers, and from 10 to 88 minutes for children and young people (mean = 38 minutes). Caregivers were asked at the start of the interviews to focus on their children's emotional outbursts prior to the COVID-19 pandemic and they were informed that there would be a specific section at the end of the interview on the effects of the COVID-19 pandemic.

Analysis

A grounded theory approach (Charmaz, 2006; Corbin & Strauss, 2015) was used to analyse the interview data in order to inductively develop the theory on how perceived safety or unsafety and sensory stimuli might contribute to the manifestation of emotional outbursts. Thus, the existing aetiological pathways framework for outbursts was utilised to direct the analysis towards the specific contexts that were queried. The analysis focused specifically on episodes that the caregivers categorised as emotional outbursts and/or episodes of behaviour that involved a loss of control, which has been identified as a characteristic of outbursts (Acker et al., 2018; S. Ryan, 2010). The present study adopted an objectivist epistemology, with the view that the perspectives of caregivers and young people participating in the study may contribute to the identification of common and potentially generalisable aetiological mechanisms of emotional outbursts in specific contexts.

The analysis involved an initial stage of line-by-line coding of all transcripts in NVivo 12 (QSR International Pty Ltd., 2018), followed by an iterative process of grouping and subsuming codes into higher-level subcategories and categories, which was facilitated by memos to explore potential groupings. Throughout the coding process, instances of codes were compared within and between interviews, and across different codes to identify and address

the gaps in the emerging theory. At early stages of the analysis, both authors independently coded four interviews to compare and agree on the coding strategy for the remaining interviews. The analysis was completed by the first author and the authors subsequently discussed and refined the resulting theory. Illustrative quotes from caregivers and young people have been included in the results to demonstrate that the emerging theory was grounded in the data.

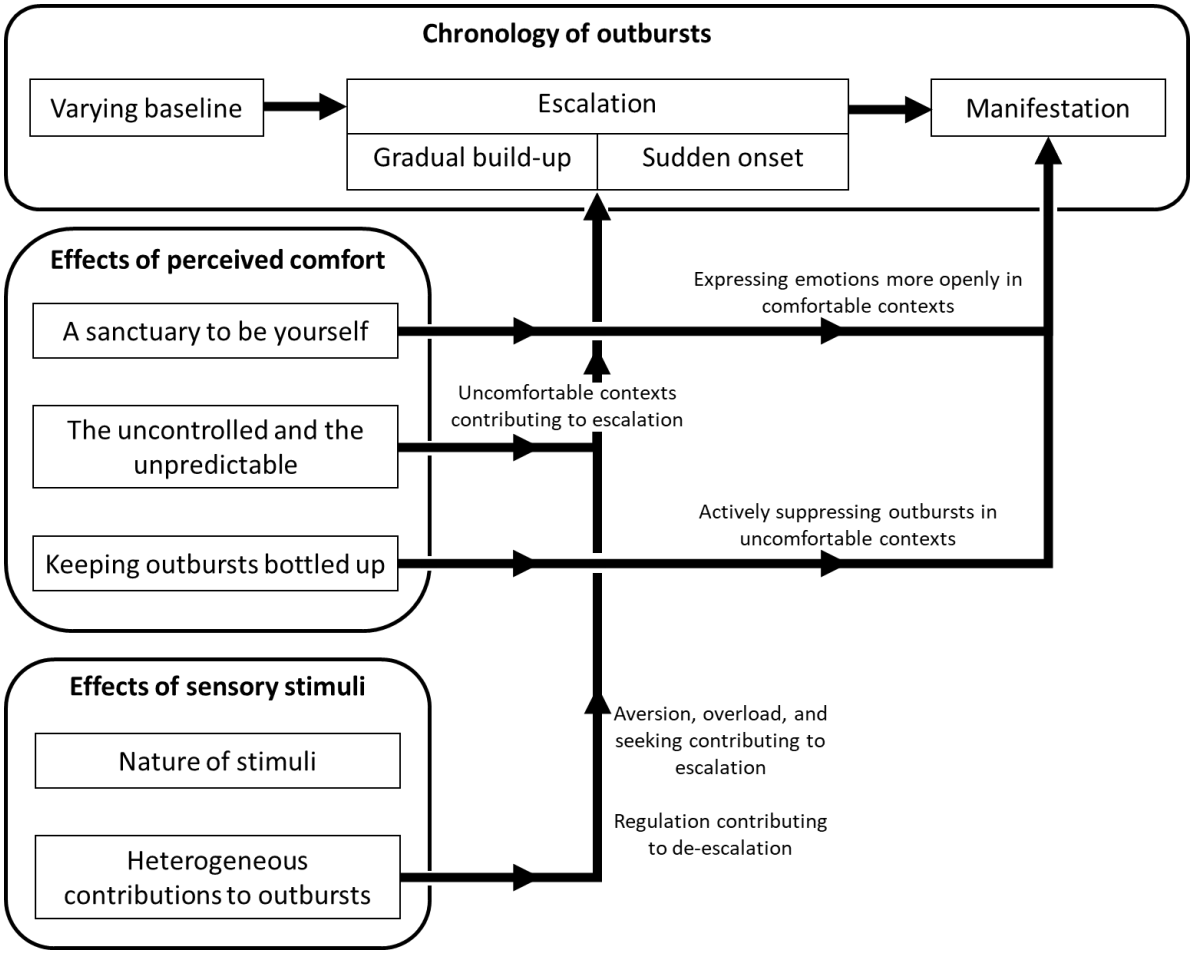
Reflexivity

As both authors were directly involved in previous research that conceptualised the aetiological pathways framework for emotional outbursts, these preconceptions were anticipated to impact the study findings. Therefore, accommodations were made throughout the study to acknowledge and minimise the bias of such preconceptions. During the interviews, the hypothesised mechanisms of outbursts were not mentioned to participants, and they were instead asked to identify mechanisms related to specific contexts through open questions (e.g., “How might the way [child’s name] processes their thoughts or emotions be related to them always having an outburst when they feel safe?”). To ensure that the findings were grounded in the data, the authors were cognisant of their biases regarding the aetiology of outbursts during the analysis. Furthermore, the authors remained open to perspectives that might challenge such preconceptions and actively sought for alternative interpretations of the data. In the presentation of the results, opposing views were included where available to demonstrate variability in the data.

Results

The categories identified in this study are organised into three core categories relating to the aetiology of emotional outbursts (Figure 5.1). The first core category described the chronology of emotional outbursts, which was found to be generally consistent across interviews and regardless of the contexts associated with the outbursts. The second and third core categories were related to how the perceived comfort and sensory stimuli in an environment, respectively, may moderate the chronology of emotional outbursts. The categories underpinning these two core categories were representative of the interviews in which the corresponding contexts were relevant (perceived comfort was relevant to the outbursts of 16 children and young people; sensory stimuli were relevant to 21 children and young people).

Figure 5.1 Summary of the chronology of emotional outbursts and the moderating effects of perceived comfort and sensory stimuli. Boxes with square corners represent categories; boxes with round corners represent the overarching core categories.



Chronology of emotional outbursts

This core category detailed the sequence of events leading up to the manifestation of emotional outbursts. At the beginning of this sequence, a child or young person possesses a baseline capacity to regulate their emotion and behaviour in response to potential antecedents, which is dependent on the emotional and physiological states of the child or young person. Escalation into an outburst can occur via one of two routes, which is determined by the child or young person's current baseline capacity and the regulatory demand imposed by potential antecedents: 1) a gradual build-up in which potential antecedents place accumulating demand on the child or young person's ability to regulate,

until the overall demand exceeds their capacity to cope; 2) a sudden onset in which the demand of a single antecedent is sufficient in overwhelming the child or young person's baseline capacity, thus reaching the threshold for an outburst. When the child or young person becomes overwhelmed by the antecedent(s), they no longer have the ability to regulate their emotion or behaviour, thus resulting in an emotional outburst.

Varying baseline

Caregivers described the ability for their children to cope with and respond effectively to potential antecedents in terms of a baseline that can fluctuate depending on the current level of regulatory demand on the children or young people. The level of imposed demand at baseline is influenced by emotional and physiological factors.

Emotional factors include the level of stress or anxiety experienced by a child and young person, which determines whether the child or young person can successfully cope with a potential antecedent or whether the same potential antecedent can escalate into an emotional outburst:

> *"one day he'll be very, very anxious about you know, something on the calendar or uh, you know, can't stop asking and gets really worked up. And then other days, where he'll accept the answer of, 'Yeah, go look. It's on the 20th.'"* (Caregiver 1)

> *"so I think it's like, if it comes to his maths and he's already 8/10 stressed, an additional 4 levels of stress would push him over the edge, won't it? But if he comes out and he's 2/10 stressed, an additional 4 levels of stress only brings us to 6, so it's still manageable."* (Caregiver 3)

For some children and young people, memories of previous traumatic experiences contribute to a persistent negative emotional state:

> *"But then there's also the fact that I am a mother and, and my husband is a father. And a mother and father figure is, who immensely like on a very extreme high scale abused him in every way possible. So here you are, y-you love both sets of parents, but one set of parents abused you in every way possible - sexually, physically, emotionally, everything. And then you're here in another home with other people that you love and part of you is always wondering when they're going to start hurting you."* (Caregiver 21)

> *"Because I- I think what memories that- that are bad do is that they- I guess they just make me more sad and upset and more down and less positive, thinking about the bad memories that happened."* (Young person 2)

Whilst the ability for a child or young person to cope with potential antecedents is primarily hindered by negative emotions, heightened positive emotions can lead to a similar outcome:

> *"a party she would I think be okay for longer because she'd be having fun. But then it might just- sometimes she can get herself too excited and then that can cause a meltdown as well."* (Caregiver 2)

The emotional state of a child or young person can be further moderated by extrinsic factors, such as medication and their caregiver's own emotional state:

> *"so I think the medication helps him cope with the anxiety. You take that away, and his anxiety is through the roof."* (Caregiver 4)

> *"if I had issues going on, he-he-he can pick up on it, they can pick up on the caregivers' mood. And that was so important for me to learn that and identify it. And then, you know, deal with it in a way that [sighs] so I could then deal with him, you know? Because otherwise he's got his issue plus my issue, then it's just- then it's a double trigger, do you know what I mean?"* (Caregiver 10)

Caregivers felt that physiological factors can similarly interfere with the baseline capacity for their children to regulate. These physiological factors were sometimes described to affect the children and young people in ways akin to how they might affect the caregivers themselves. For example, caregivers attributed tiredness as a key physiological factor that limits regulatory capacity:

> *"Um, tiredness is a massive factor. So you know, as she- which obviously as we'd all get, you know, she's more irritable and more ready to sort of explode if she's tired."* (Caregiver 2)

On the other hand, illness has varying effects on children and young people's propensity to experience outbursts:

> *"if he's unwell and feeling- not feeling himself, then his- his resources are lower."* (Caregiver 3)

> *"if he gets sick, he just wants to sleep and have Mum look after him. So he wouldn't have one when he's sick, doesn't affect it."* (Caregiver 10)

Other physiological factors impacting the baseline regulatory capacity include a child or young person's diet or menstrual cycle:

> *"Whatever it is, it's just he's unable to, um, you know, he- he's more tired. He's more everything negative when he's eating gluten. So it just like a well- more well-oiled machine when he's not on it, everything can just function to its- the best capacity that he can have when he's not eating it, you know?"* (Caregiver 10)

> *"but I would say that you know, for your research, it's really important, but I think it's around her period."* (Caregiver 11)

Escalation - gradual build-up

A child or young person may face the accumulating demand of potential antecedents over time, which culminates in an emotional outburst if the overall demand exceeds their capacity to regulate (i.e., passing their regulatory threshold).

This type of escalation is characterised by a period of sub-threshold build-up of demand, which was described by caregivers in terms of mounting pressure on the children and young people:

> *"I just think it's a- it just builds up, you know? It's like um, a cloud of dust, I suppose- [laughs] -that just gets bigger and bigger and explodes"* (Caregiver 5)

> *"Basically, I think she reaches a point [interviewer's name] where she probably replays over and over in her head what's gone on in school and it just literally, it's like shaking a bottle of pop, almost."* (Caregiver 22)

Furthermore, the demand of multiple discrete antecedents can contribute additively to this escalation:

> *"Parent 1: You know, could be a change in her day that she didn't like and then it could be a change in the nurse from that day and it could be a change in, I don't know, just the way hair was done or I mean, it could be any little change like that triggers it. She didn't get to ride in the truck and she had to ride the car or-*
>
> *Parent 2: Just builds up on top of each other."* (Caregivers 8)

The length of the build-up period varies across children and young people, but it can also vary considerably within an individual:

> *"the outburst will only happen after he's brewed on it for an hour or two weeks."* (Caregiver 10)

Caregivers can typically identify this period of gradual escalation based on either specific behaviours that children and young people may display or differences in how children and young people behave compared to their baseline. However, these specific behaviours or differences are individualised, and there was no consensus on how children and young people may behave differently during this build-up:

> *"one thing that happens when he's very uncomfortable in environments like this, he becomes- the beginning um, before the [outburst], he begins with uh, very stereotyped behaviour like this with the hand and uh, he- he began to- to feel that uh, how- how can we say uh, he moves um, himself very um, very much, you know."* (Caregivers 18)

> *"if it's like a social frustration, it's like you can tell it brews up a bit slower. You can sort of see it brewing up in him."* (Caregiver 23)

Similarly, caregivers reported that children and young people can sometimes recognise and potentially communicate this build-up:

> *"He said, 'The problem is Mummy, I've been so good for a long time, and I can feel that anger inside bubbling up and it needs to come out, and I don't know what to do.'"* (Caregiver 17)

This stage of escalation was identified by caregivers as an opportunity for de-escalation, as children and young people are more receptive to external interventions during this period compared to when the situation fully escalates into an emotional outburst:

> *"we're not at the meltdown stage yet, but we're at the you know, where that transition from, um, trying to control the situation and that in between phase, which, you know, depending how it's handled leads to men- meltdown. He now, we can sometimes just get to that phase and defuse it again"* (Caregiver 20)

As regulatory demand approaches the threshold at which the child or young person can no longer cope, an emotional outburst can be triggered by a minor antecedent that the child or young person can typically tolerate:

> *"it's got to just be down to how much she feels she can take on board at that given time. It- it's literally like you know the straw that broke the camel's back kind of scenario. It could just be that one little thing will tip her over the edge, whereas at other times, she's able to keep taking those little things for longer."* (Caregiver 22)

Furthermore, the antecedent that finally triggers the outburst can be unrelated to the cause of the initial escalation and the underlying distress experienced by the child or young person.

Caregivers may not immediately recognise this masking effect of the final antecedent at the time of an outburst, but can often identify the cause of the escalation in hindsight:

> *"that can be, 'What are you getting upset about that for?' But you know, really, it's not about that. It's about the fact that she's having a blood test. And I think we can sometimes forget that. That it's not always about 'the thing'."* (Caregiver 5)

Escalation – sudden onset

Caregivers additionally described episodes of emotional outbursts that occur suddenly and without gradual escalation. This form of escalation represents a parallel route through which outbursts can manifest.

Some antecedents have sufficient potential to overwhelm a child or young person's baseline regulatory ability and fully escalate into an outburst:

> *"It can- I don't think it builds up, yeah, I think it's any moment can kick, be 0-100."* (Caregiver 15)

> *"You can be fine and he can be at the skatepark and if he kind of like bumps himself or if somebody accidentally bumps into him, then he can really fly at them and attack them."* (Caregiver 23)

Caregivers also described the onset of outbursts that are unpredictable and happen out of the blue:

> *"Other times, she'll wake up and she'll be singing in the morning and happy as a clam and then [claps], out of nowhere, she's full tilt meltdown."* (Caregivers 9)

For these types of unpredictable outbursts, most caregivers reported difficulty in identifying the underlying cause even in hindsight. However, a caregiver suggested that these unpredictable outbursts may be preceded by periods of build-up that their child has fully internalised, such that the caregiver may be unaware of the sub-threshold build-up prior to the onset of these outbursts:

> "*Most times it's out of the blue, she's obsessing about something, and we don't even know where it came from and the wave hits."* (Caregiver 16)

Manifestation

When the demand of potential antecedents overwhelms a child or young person's regulatory capacity either through a gradual build-up or a sudden onset, the child or young person experiences an emotional outburst, which caregivers considered as a phenomenon discrete from other types of behaviour.

Children and young people experience a loss of control over their emotion and behaviour as emotional outbursts manifest:

> *"He can't cope and he's not in control of his actions when- when he shows this behaviour. He is kind of overwhelmed. You have to help, we sort of have to help him when he's in a meltdown, because he can't help himself."* (Caregiver 23)

This loss of control persists from the onset of outbursts despite efforts from children and young people to prevent it:

> *"he says things like, 'I can't control it yet. I know what to do, but I can't do it.' So he's been saying that for as long as I've known that, you know [pauses] it's something beyond his control"* (Caregiver 17)

> *"I think sometimes distracting myself worked. But sometimes it doesn't because sometimes, I'd just think about the bad memory and then scream first before I can stop myself."* (Young person 2)

From the caregivers' perspectives, this loss of control component set out a clear distinction between emotional outbursts experienced by children and young people and "tantrum" behaviours that may be expected of typically developing toddlers:

> *"I think for me the term 'meltdown' sort of encapsulates the loss of control that's maybe going on. The, you know, it's not a deliberate ploy that the child is using to get something out of you or to get their own way, or something. It's an action. It's something where things have spiralled out of everyone's control. And um, and certainly my view of it is that um, while there are moments of control in what goes on, I think sometimes. Um, the driving force behind what's happening is not in the child's control."* (Caregiver 3)

> *"And I think it's very clear, the difference between, especially when they were young you know, like a toddler tantrum and someone's not getting their own way, and they think that being cross with me will change my mind. Just against when [young person's name]'s having a meltdown, where he doesn't have the control about what's going on at that moment."* (Caregiver 19)

Furthermore, caregivers can identify the onset of outburst by the changes to their children's typical demeanour. As Caregiver 12 described: *"she starts like becoming another person."* The specific look in the eyes of the children and young people is one unique characteristic to outbursts that some caregivers utilise to distinguish outbursts from tantrum behaviour:

> *"the look in her eyes when she's having [a tantrum] is different. Uh, she's more clear-eyed and you know, she's kind of with you, if- you know, so to speak, compared to when she has these just out of the blue epic melts um, where she's not really focused on anything other than the eruption in her own head."* (Caregivers 9)

> *"Um, sometime, it's really um, out of the blue, but you can see on his- in his eyes, he doesn't have the same look. So I know it's not my- my- my [young person's name]. It's the- the other one."* (Caregiver 14)

Although some caregivers recognised that episodes of emotional outbursts can involve learned behaviour elements similar to how tantrums may operate, they felt that there is nevertheless a fundamental difference between outbursts and tantrums:

> *"And it's- it's just so consistent that, you know, there's a lot of learnt behaviour in there, but it's still an outburst sort of thing."* (Caregiver 6)

> *"So he's not- he's not doing it for effect. He's not you know, I mean some of it is learned behaviour in his case as well but you can tell the difference between him and- he's got a sibling that lives with me, and her- her behaviour sometimes it can- when she was young, was as extreme but was very much to get a goal, yeah- there was a- she thought that she would get what she wanted if she carried on."* (Caregiver 19)

However, some caregivers acknowledged that the distinction between emotional outbursts and what may be considered normative behaviour for children and young people is not always clear:

> *"Kids will always to get your attention would cry, would shout, uh, would run, what- whatever they think they can do to get your attention. And I think that's normal for a kid. Uh, and I don't know when- when it's normal and when it's not."* (Caregiver 12)

Effects of perceived comfort

A series of categories details how the level of perceived comfort (or the lack thereof) in an environment contributes to the escalation and manifestation of emotional outbursts in some children and young people. In the present context, the concept of comfort encapsulates a range of inter-related aspects, including the safety, familiarity, predictability, and controllability of an environment. This outcome differs from the study's original focus on perceived safety, which had been previously hypothesised as a key contributor to two patterns of contexts associated with outbursts (Chung et al., 2022). Although caregivers predominantly related emotional outbursts to the safety of an environment, the broader focus on perceived comfort is more reflective of the perspectives of caregivers, as some caregivers found other facets of comfort more salient (e.g., for Caregiver 6: *"it's definitely familiarity, but I don't think it's safe. I suppose she's never been anywhere without someone that she'd feel safe with because she's seven.*") and described them in relation to outbursts in a similar way.

A sanctuary to be yourself

Some children and young people commonly experience emotional outbursts in comfortable contexts, where they feel able to openly express their emotions.

Indeed, emotional outbursts are sometimes the only means through which children and young people feel able to express their emotions. Therefore, despite the negative impacts of outbursts, caregivers recognised the necessity for children and young people to have an outlet for their emotions:

> *"and he said, 'The problem is I don't think there's anything [that can prevent a meltdown].' Anyway, that night he had a massive meltdown. And when it finished, he said, 'I told you. There's nothing I can do.'"* (Caregiver 17)

> *"I think he needs, sometimes he just needs to have the meltdown to let out all of that pent up emotion. And then as I say once it's out, he can move on. It's like it's done with and then he doesn't have to rethink about it. Erm so I think sometimes he just has to let it out in one way or another, so I think sometimes it's being- and he can't always verbalise it."* (Caregiver 19)

Given that children and young people may feel particularly vulnerable during emotional outbursts, caregivers shared the consensus that the safety associated with the caregivers themselves and the home environment help children and young people feel able to express their emotions:

> *"He knows that if he feels those emotions here, and he shows them that I'm not going to reject him, I'm not going to hurt him. Erm so you know, he's got that."* (Caregiver 21)

Caregivers felt that their unconditional acceptance of their children is a key contributor to the perceived safety and comfort of the home environment, which directly contrasts with people in other contexts who may not share the same sentiment or understanding:

> *"Because right away, my mum wants to stop it and be critical. Normalise it, right? Whereas I'm like just let it- let it have its course, you know? Let her deal with whatever she needs to deal with and get it out. Yeah. So she feels safer to be herself with me and at home than she would elsewhere."* (Caregiver 11)

Furthermore, this level of perceived safety can extend to contexts beyond the home and the caregiver, but it often requires time to develop:

> *"She wouldn't display it in front of [her grandparents] when she was with us, um, she only displayed it when they weren't around, but then obviously after a while, once she started feeling safe and staying at grandparents' house, it eventually- she'd do the same there as well."* (Caregiver 22)

The uncontrolled and the unpredictable

Emotional outbursts frequently occur in uncomfortable environments for some children and young people, who appear to particularly struggle with the uncontrollability and the unpredictability of the surroundings.

Although caregivers commonly described their children's difficulties with these contexts being related to either uncontrollability or unpredictability, these two concepts can be argued as describing the same type of situation from different perspectives:

> *"I think that um, these kids- if they- if their whole life is a mystery, and if they don't know what's happening, and there's no routine, that's- that's tough. They don't- they don't feel any control."* (Caregiver 4)

> *"So he kind of- it can seem almost like that kind of terrible twos sort of stage, where if he doesn't get his own way, so he can be very, very controlling. And particularly if he's- if he's feeling a bit uncertain about things, and I try to do schedules and things with him, but if there's any kind of uncertainty about what he's supposed to be doing, then he will try and sort of take control"* (Caregiver 23)

Furthermore, outbursts arise from some of these contexts because children and young people perceive the lack of control or the lack of predictability as direct threats to their own safety:

> *"So I think there's partly a control thing, which is, 'I- you get away. I need to get you away from me now because you're endangering me. And I'm the one- I am going to keep myself safe. And I'm doing that by getting you away.'"* (Caregiver 3)

> *"If he knows you got control of the situation, you're going to keep him safe, then in the back of his brain it takes over and he's like, 'Okay. I don't have to escalate this further.' Err it's, it's all about that feeling of safety. And the second I'm afraid, I'm not in control. I think that's all it comes down to. Err. But if I am in control or fake being in*

control, then he gets comfort from that and he's able to allow me to help him." (Caregiver 21)

Uncomfortable environments can contribute to the manifestation of emotional outbursts through both routes of escalation. Caregivers described instances of sub-threshold build-up due to uncomfortable contexts:

"Especially if he's not prepared ahead of time for- like if he doesn't know what's happening, he's very prone to being pushed over the edge." (Caregiver 4)

"but that is combined also by some of his anxiety being heightened by the other children where he doesn't feel safe with them, because they have physically hurt him." (Caregiver 19)

Furthermore, these uncomfortable contexts can act as the final antecedent to an emotional outburst in an escalated situation:

"once you start pushing him, then- then the problem you've got there is that I'm supposed to be the person that keeps him safe. And instead of keeping him safe, from his point of view, I'm forcing him to do the thing that he feels very unsafe doing. So I mean, I think that heightens up his fear. So I mean, I think that heightens up his fear beyond, 'I'm frightened of riding me bike here' to, 'Now, I'm just generally terrified, because the person I'm relying on to keep me safe is in my point of view forcing me to do a thing that I consider to be very unsafe. That makes no sense. I can't compute that in my mind.'" (Caregiver 3)

Additionally, these contexts can directly trigger the sudden onset of emotional outbursts without prior build-up:

> *"So, any level of disappointment- erm plans not going the way he had expected it to go. Erm can cause that to happen."* (Caregiver 19)

> *"there's days he's expecting pasta and he's getting rice and he's just like freaking out"* (Caregiver 20)

Keeping outbursts bottled up

Despite the distress they may experience in uncomfortable contexts, some children and young people are motivated to actively prevent the manifestation of emotional outbursts in these environments.

Some children and young people mask the distress they experience in uncomfortable contexts. Although this distress is not outwardly displayed or communicated, it nevertheless contributes to sub-threshold escalation towards outbursts:

> *"But usually, if- if he was with strangers or people he didn't know very well, or um, he- he would try and bottle that up really, rather than display that stuff in front of people. He's intensely private."* (Caregiver 3)

> *"so if something happened and he's out in public, he would just brew on it. He would just internalise it and it manifests inside him."* (Caregiver 10)

Furthermore, children and young people can delay the manifestation of emotional outbursts until they return to comfortable contexts, where they feel more able to express their suppressed emotions:

> *"But she'll pick on something that's happened whilst they've been out, and it might only be a minor thing but for her though, that's- that's- that's it then. She's never doing it with them again and, [huffs], because she'll never do anything in front of them but it could be as quick as when we get into the car, and it's just the two of us again, she'll have an outburst."* (Caregiver 22)

> *"he saves it more for when he's at home, so he kind of, I think of like he bottles up stress through the day. He tries to sort of keep a lid on it a bit."* (Caregiver 23)

However, some caregivers found that the delayed outbursts in comfortable environments can be avoided if they intervene and help their children de-escalate from their internalised distress:

> *"afterwards we manage him really well. We would stick on a movie or run a hot bath or give the deep pressure and reward him. 'That was a really difficult situation. You managed that so well and that must have been so frustrating, but well done. Here's whatever.'"* (Caregiver 17)

> *"if you give, you know that ten minutes was playing a childish game with him. Just with him, you know, and completely giving- reconnecting, giving all the attention to him, then that could often reconnect it in a way that he would- could let go of whatever had happened earlier."* (Caregiver 19)

Caregivers identified several motivations for children and young people to mask their distress and outbursts in uncomfortable environments. Some children and young people suppress their outbursts due to the fear of how people in uncomfortable contexts may react:

> *"And then he does know that you know, he does know he is safe here and therefore, he can let some of it explode out and- and he'll survive it, whereas he's again due to some of his previous experiences, he doesn't know with the new adults if w-what the consequence will be."* (Caregiver 19)

> *"Like, she doesn't know if she had an outburst, say in school, she doesn't know how they would react to that because obviously it's not anything she's ever done."* (Caregiver 22)

For other children and young people, the motivation to suppress outbursts outside of the home environment stems from their understanding of societal expectations of acceptable behaviour:

> *"And I think it's along the lines of we- we speak and behave to the people in our closest communities and our household in a way we wouldn't speak to strangers on the street. So even it- not even in terms of meltdowns, but even as adults, we might allow a level of irritation to show with our partner, that we wouldn't do that in a professional context. We control it, but we develop a different pattern of being, don't we? With people that we are more intimate with in our relationships. And I guess it's just an extension of that, really."* (Caregiver 3)

> *"Because you know, I- I remember when we go out- when we go out into the public, you are not allowed to have an outburst out there in the public. Because- because I guess it's you have to be respectful to the community. I guess you have to- you have to have a certain behaviour to I guess go out there."* (Young person 2)

Some children and young people are additionally motivated to adhere to these social norms to maintain social desirability amongst peers:

> *"If it happens at his friend's house, he will move away and he will control it, but he will be able to calm- he will be able to grab control of that because he doesn't want to lose that one friend by having the meltdown, which probably comes back to the conversations that I've had: 'If you show that behaviour at people's houses, they are not gonna invite you.'"* (Caregiver 17)

> *"I think he wants- he wants to fit in more these days um, socially. He doesn't want to seem different to other kids, whereas at home, you know, there's nothing- there is no fitting in to have to do."* (Caregiver 23)

Attempts by children and young people to mask their distress in uncomfortable contexts demonstrate variable success. For some children and young people, their masking is always successful:

> *"She's never ever been out with anyone where she's done anything. She's always, you know, very mild-mannered, very polite, very calm, um, completely different to how she demonstrates during an outburst."* (Caregiver 22)

Due to the effectiveness of successful masking, people in these uncomfortable environments may not realise the difficulties the children and young people are experiencing:

> *"Especially when he started the secondary school in September, erm they were only seeing a very well-behaved person. And then he would come home and completely lose the plot for three hours because he'd held it in all day"* (Caregiver 19)

Unfortunately, other people in these uncomfortable environments (e.g., at school) may be unaware that a child or young person may be internalising their distress and internally escalating towards an outburst. This can lead to further demand being placed on the young person, which can consequently act as the final antecedent in the gradual build-up to an emotional outburst if the regulatory capacity of the child or young person is exceeded. Furthermore, the effort of masking can directly reduce the resources available for the child or young person to cope with this additional demand:

> *"if he's been coping, and this is where people find it really hard to- to recognise the trigger. If he's been doing really well, but trying really hard to do really well, and then suddenly he can't because he's fatigued and he's been trying so hard. … It's interesting because the- the trigger can just be trying really hard to do everything that's expected of the world. And when you are doing really well, people tend to load more on you."* (Caregiver 17)

Alternately, some children and young people may be less able to suppress their outbursts in specific contexts. Examples of scenarios where masking may be unsuccessful include uncomfortable contexts where the child or young person may be motivated to establish control or contexts that are too overwhelming for the child or young person to internalise:

> *"the skate park is a big one, where he can't really hold it in very well because um he- he finds it group situ- group dynamics very difficult because he always wants to be in control."* (Caregiver 23)

> *"But if there's a big trigger if he- you know if something happened so for example erm I was- I fell over once walking a dog and I cut myself and people were helping but*

actually we had to all deal with his meltdown before we could deal with me bleeding." (Caregiver 19)

Effects of sensory stimuli

The final core category illustrates the ways in which sensory stimuli moderate the escalation and manifestation of emotional outbursts for some children and young people.

Nature of stimuli

Caregivers described a wide range of sensory stimuli that are linked to emotional outbursts. These stimuli span across the spectrum of sensory modalities (e.g., hearing, sight, touch, taste, smell, balance, temperature), with auditory inputs being most commonly associated with outbursts:

"If he is in a uh, environment- a loud environment, he will be very quickly excited" (Caregiver 14)

"anything wet and slimy would trigger him." (Caregiver 10)

"I think that the- the physical contact, she doesn't like physical contact as any other regular kid, you know?" (Caregiver 12)

A child or young person's specific sensory sensitivities or processing difficulties were often attributed as the underlying reasons for the relationship between sensory stimuli and outbursts. However, some stimuli associated with emotional outbursts are not explicitly linked to underlying sensory differences in the child or young person, although these differences could not be ruled out. For example, some children and young people experience emotional outbursts in response to pain or physical discomfort:

> *"Now, what we think could be triggering them, I think sometimes it's [gastrointestinal]. Um, I think you know, she gets a lot of- she gets [laxative] every day and she takes [laxative] every day. And that can make your stomach go [rumbling noise] you know, bubbly and stuff like that feeling. So sometimes I wonder if it's pain."* (Caregivers 9)

> *"Um, and they- and they can just be like fight or flight as well, so sometimes it's slightly more of like an angry outburst, but sometimes it's more of just a fight or flight. If it's like a sensory thing, it's much more kind of just reacting to you know, um, 'I feel pain, so I'm just going to lash out.' So it's much more sort of automatic like knee jerk thing."* (Caregiver 23)

Furthermore, the reactivity to a stimulus can be due to an association with past trauma:

> "*The smells and the foods, I know all of that has to do with his past trauma. It does. Because they didn't- they never lived in clean place. They, the kids maybe never had enough food. Probably ate rotten food, you know. So, he's very, very triggered by smells and I know that those come from his past trauma."* (Caregiver 21)

Heterogeneous contributions to outbursts

Caregivers identified four manners in which sensory stimuli can moderate the likelihood of emotional outbursts: aversion, overload, seeking, and regulation. These categories are not mutually exclusive within an individual (e.g., a young person may react to both aversive and overwhelming sensory stimuli) or within a sensory modality (e.g., a young person may react to overwhelming sounds, but sounds may also help the young person regulate).

Aversion. Sensory stimuli that are aversive to children and young people can contribute to the manifestation of emotional outbursts through both routes of escalation:

> *"it wasn't the [sensory-related] activity itself that would cause the meltdown. The activity itself would cause a reaction in him. A negative reaction. But you wouldn't necessarily categorise it as a meltdown. What would cause the meltdown was me [laughs] insisting he continued doing the activity, even though he clearly didn't like it."* (Caregiver 3)

> *"I can remember though when he was younger um, and he still had a feeding pump, and the pump would alarm, and that noise would set him off or if it's like that beeping. Or if we were in a car and we started driving before one of us had our seatbelts completely buckled and that beeping. Those kinds of noises would set him off when he was younger"* (Caregiver 7)

> *"it was a big plasma screen and you could tell that he lasted a few seconds of the screen thing being on and then he just ran, like off into this crowd like it was a huge great you know, meltdown."* (Caregiver 23)

Overload. Similarly, excessive sensory stimuli can escalate into emotional outbursts through either a build-up of demand from multiple sources of stimulation or an overwhelming demand from a single stimulus:

> *"Parent 1: because she does have hearing problems, she doesn't- she's got like mild or moderate hearing loss, but the noise was too much because there was probably like 20-25 kids yelling and screaming and running and everything else and she was fine*

once we put her earplugs in-

Parent 2: it was like sensory overload" (Caregivers 8)

"Um, but there's obviously a lot of people and a lot of stimulation. And at times, she-she's had a couple where it's just so much stimulation I think it triggers it." (Caregivers 9)

"It's too much of one thing. It's too much of a sense, you know? It's like too much food or too much water. It's too much of something." (Caregiver 12)

Furthermore, some caregivers described the chaotic nature of the sensory environment as the primary contributor to escalation through sensory overload:

"So the actual volume of people with the focused activity's absolutely fine. What's not ok is all that queuing and getting into your seat and everyone getting out of their seat and everybody talking. So at school, that happened all the time in between lessons, going to playtime, going to assembly. It's that unorganised chaos at all times." (Caregiver 17)

Caregivers identified a range of processing difficulties as the underlying mechanism through which outbursts can manifest from sensory overload. These difficulties include deficits in global processing and the speed at which stimuli can be processed:

"I think it's just that there's too much going on. Too much to see. Too much noise. Too much to process." (Caregiver 2)

"he's kind of like the blind man and the elephant. He can't take in the whole elephant. He takes it in one piece at a time." (Caregiver 4)

> *"I think the speed at which people talk on the music happen- is too fast for his brain to process, at which point it's just a noise and frust- it just triggers frustration."* (Caregiver 20)

Seeking. Caregivers reported that situations involving sensory seeking behaviour can sometimes escalate into outbursts for children and young people. For example, the activity that the child or young person is pursuing for sensory input may directly escalate into outbursts:

> *"Other times he's playing some beautiful song but sometimes it just becomes a stim and he might hear one note being held for a really long time and you just- you wait for it. You know it's going to happen."* (Caregiver 7)

Furthermore, escalation may occur if the activity does not provide satisfactory sensory inputs, which may be dependent on the child or young person's baseline:

> *"But on days where he doesn't feel well physically or if he's tired, or just feeling anxious for whatever reason, those things that he stims on might not feed him the way he wants and so then comes an outburst."* (Caregiver 7)

> *"as I stop and think, you know, could those little OCD tendencies trigger an emotional outburst if she's not getting the satisfaction from it?"* (Caregivers 9)

Some children and young people are frustrated by a lack of sensory input altogether, which can similarly contribute to escalation:

> *"if he hasn't had some sensory input recently enough. Like if he is without it for a long time, then he might be more likely to have- routine regimen of sensory input is probably important for him."* (Caregiver 4)

> *"Um and that was one of the little tests we did [with the clinical psychologist]. We like put him sitting alone for ten minutes just to see what he would do um, because I did tell her the same thing – boredom is his kryptonite. ... I think if we had let that go for another ten minutes, we probably would have seen an outburst."* (Caregiver 7)

Regulation. Whilst sensory stimuli can escalate into outbursts as described above, a wide range of stimuli (e.g., physical pressure, loud music, smells, sensory toys) possess the potential to de-escalate situations, which caregivers often integrate into interventions for outbursts. These strategies appear to be effective in de-escalating across contexts and are not limited to sensory-related escalation:

> *"And I'll just say to her, 'Do you- you know, do you want your sensory bag?' And she'll say, 'Yes, please.' And she'll choose something from there and play with it for a couple of minutes and she's usually okay after that."* (Caregiver 5)

> *"Sometimes he just wants kind of some physical input like some squeezes."* (Caregiver 7)

> *"Anything he can smell, helps him regulate if it's a nice smell."* (Caregiver 21)

Caregivers noticed that depending on the environmental context, some stimuli (e.g., loud sounds) can either escalate into, de-escalate from, or have no net effect on outbursts. A key

determinant of a child or young person's response is whether the child or young person is in control of the stimulus:

> *"Um, I think for the most part he does have outbursts with loud or sudden noises, but there are times where he'll be listening to music in his headphones and have it blasting. Um, so maybe if he can control it, he's fine with it."* (Caregiver 13)

> *"It's an interesting thing with him because, at home um, he chooses very loud activities like dumping toy cars into a bucket, um, and so it's more if he has control over the loud sensory input. He is fine with it at home."* (Caregiver 15)

> *"At school they gave- if they give him control over the sound, it's ok. So the school bell could knock him over the edge, but if he's ringing it, it won't."* (Caregiver 17)

Discussion

This study utilised the perspectives of caregivers and some children and young people with neurodevelopmental conditions to develop our understanding of the aetiology of emotional outbursts. The results identified fundamental processes involved in the manifestation of outbursts, whereby the regulatory demand of potential antecedents can overwhelm a person's baseline regulatory capacity via either a gradual build-up or a sudden onset, such that the person loses their normal capacity to control their emotion and behaviour. The impact of the environment on the escalation and manifestation of outbursts can generally be understood in terms of the level of control a person has in a given environment. The effects of perceived comfort were characterised in terms of how the lack of control over uncomfortable environments can exacerbate escalation into outbursts, and how comfortable contexts may enable the expression of outbursts, whereas uncomfortable

contexts can instead suppress outburst manifestation. Sensory stimuli across modalities were found to have the potential to facilitate both outburst escalation and de-escalation, which are dependent on the level of control a person has over a sensory stimulus and individual differences in sensory processing.

The categories identified in the chronology of outbursts consist of concepts that have often been implicitly assumed, such that they have not been adequately defined in prior research (e.g., Chung et al., 2022). Therefore, although the present study originally aimed to focus on the context-specific aetiology of emotional outbursts, the characterisation of these general mechanisms of escalation and manifestation is integral in defining the bounds within which the context-specific effects may operate.

The notion of a varying baseline regulatory capacity is consistent with the momentary fluctuations of emotion regulation (Aldao et al., 2015; Colombo et al., 2020) and accounts for the contrasting responses that instances of the same antecedent may evoke in a child or young person. Furthermore, this category emphasises the influence of emotional and physiological factors which may not be directly related to the manifestation of outbursts but can still accentuate the ability for potential antecedents to trigger outbursts. Whilst the effects of common factors such as tiredness and illness on outbursts have been acknowledged in prior research (e.g., Tunnicliffe et al., 2014), the present findings provide further insight into how these factors influence outbursts, in addition to integrating the contributions of additional factors that have received less attention, such as the experience of positive emotions, diet, and menstrual cycle.

The present findings describe two routes through which a child or young person can escalate from their baseline towards an emotional outburst. Caregivers offered illustrative analogies to describe the accumulating regulatory demand on children and young people during episodes of gradual build-up. These accounts are consistent with our theoretical understanding around the resource cost of emotion regulation (J. J. Gross, 2015; Sheppes et al., 2014), and they may provide a basis for the implementation of measures (e.g., visual analogue scales combined with physiological measures; Colombo et al., 2019, 2020) to monitor a child or young person's momentary regulatory capacity in clinical and research settings. Development of effective monitoring systems for the escalation of outbursts may be especially critical given that interventions were reported to be most effective during this period of build-up. For emotional outbursts that escalate suddenly without an apparent antecedent, it is of note that intrinsic antecedents (e.g., a fixation on a thought) and potential internal build-up could not always be ruled out by caregivers. Although it was outside the scope of the present study, the process of de-escalation warrants further investigation, as a thorough understanding of the mechanisms of de-escalation may be especially critical for intervention development.

In terms of the manifestation of emotional outbursts, the loss of control experienced by children and young people is a defining characteristic, which has been identified in previous work (Acker et al., 2018; S. Ryan, 2010). Furthermore, many caregivers in the present study can intuitively distinguish between emotional outbursts and "tantrum" behaviour that appears similar but instead has a learned function (e.g., demand avoidance; Matson et al., 2011). Whether the intuition of the caregivers can be distilled into a set of quantifiable differences between these two types of behaviour should be explored in future work, as the

caregivers in the present study were not specifically asked to define these differences in objective terms. Regardless, the present findings highlight the importance of caregivers' insight in understanding the behaviour of their children and young people. Unfortunately, the perspectives of caregivers are not always acknowledged by support services, which may instead place blame on children and young people for deliberate misbehaviour (Danker et al., 2019; C. Ryan & Quinlan, 2018; Starr & Foy, 2012). Based on these findings, we reiterate our call (Chung et al., 2022) for researchers and professionals to be mindful of the terminologies used to describe these episodes and propose the shift to the term 'emotional outburst', which has also been independently proposed by Carlson et al. (2022).

Overall, the processes entailed in the chronology of outbursts can be considered an extension of the contextual pathways framework, whereby the principles of escalation and manifestation can apply across contextual pathways, and each pathway is defined by the manner in which a specific set of contexts may moderate the processes of escalation and manifestation. Based on the present results, the mechanisms of distinct pathways related to perceived comfort, perceived discomfort, and sensory stimuli were identified. It should be noted that the pathways are not mutually exclusive at the individual level, such that any number of contextual pathways can be applicable for a child or young person.

With regards to the influence of perceived comfort on outburst aetiology, the present study found that this broader term was more representative of the range of perspectives of caregivers compared to the original focus on perceived safety, but perceived safety remained the primary facet of these contexts for many caregivers. The perceived comfort associated with caregivers and home is of particular interest, as previous work has identified

the home environment as one of the most common contexts for outbursts (Cressey et al., 2019; Rice et al., 2018). The present findings suggest that outbursts happen more at home and in other comfortable environments due to children and young people feeling more able to express their emotions through outbursts (i.e., moderating the manifestation of outbursts), in contrast to other environments that may operate through the potentiation of outburst escalation.

The unpredictable and uncontrolled aspects of uncomfortable contexts directly contribute to the escalation of outbursts. Given the conceptual overlap between unpredictability and uncontrollability, and the pervasiveness of these aspects in uncomfortable contexts, it is possible that the pathway to change-related outbursts that has been described in people with Prader-Willi syndrome (Woodcock et al., 2009b) could be subsumed under the pathway to outbursts in uncomfortable environments. If this were indeed the case, one mechanism through which uncomfortable contexts might contribute to the escalation into emotional outbursts could be an impairment in task-switching that could exacerbate the regulatory demand of these environments (Woodcock et al., 2011). In any case, further unidentified mechanisms are expected to operate in uncomfortable contexts and the interactions between these and identified mechanisms warrant further investigation.

A further pathway to outbursts was outlined for some children and young people, in which outbursts manifest almost exclusively in home environments due to the masking of outbursts outside of home environments, which corroborates the pattern of outbursts identified in previous work (Chung et al., 2022; Cressey et al., 2019). The suppression or masking of outbursts in uncomfortable environments appears to be a combination of the

processes of behavioural camouflaging in the autism literature and expressive suppression in the emotion regulation literature, both of which have been associated with negative psychological outcomes, which can conceivably exacerbate the difficulties children and young people may have with outbursts by altering their baseline regulatory capacity (for reviews, see Cook et al., 2021; J. T. Gross & Cassidy, 2019). From an intervention perspective, it may be beneficial to raise awareness of outbursts related to this pathway in settings outside of the home environment (e.g., in school, or other care settings), so that escalation can be avoided if those supporting the children and young people can recognise and resolve the difficulties that the children and young people may be experiencing internally.

The relationship between sensory stimuli and outbursts was determined by how the stimuli contribute to escalation towards outbursts, which appears to be independent of the sensory modality of the stimuli. The three moderating effects of sensory stimuli that exacerbate outburst escalation (aversion, overload, and seeking) closely resemble three out of four established profiles of sensory processing (sensation avoiding, sensory sensitivity, and sensation seeking; Dunn, 2007). Therefore, conventional interventions that specifically target difficulties in these domains of sensory processing (Dunn, 2007) may be effective in attenuating the influence of sensory stimuli on outburst escalation. Indeed, some caregivers in the present study reported that occupational therapy around sensory processing has ameliorated some of the difficulties that children and young people have in relation to sensory-related outbursts. Furthermore, the use of sensory strategies to de-escalate from outbursts across contexts should be explored further to understand the underlying mechanisms and operating conditions of this type of intervention. The present findings suggest that sensory stimuli can contribute to escalation directly, but it remains unclear to

what extent differences in sensory processing can account for the pattern in which the propensity for outbursts is heightened across contexts (Chung et al., 2022). With regards to the contribution of pain and discomfort to the gradual build-up towards emotional outbursts, it is possible that communicative ability may have a mediating role in such a relationship similar to its role in the proposed model between pain and self-injurious behaviour in people with severe intellectual disabilities (Oliver & Richards, 2015). In the present context, some children and young people may be unable to communicate feelings of pain and discomfort due to persistent impairments in communicative ability, whereas the communicative ability for other children and young people may be temporarily limited by the accumulating demand of the pain and discomfort. In both scenarios, the source of pain and discomfort may remain unresolved, thereby continuing to contribute to the escalation towards outbursts.

A strength of the present study is the inclusion of caregivers of children and young people with a diverse range of neurodevelopmental conditions. Whilst previous studies have demonstrated the low between-group variability of observable characteristics of outbursts in terms of behaviour and context (Beauchamp-Châtel et al., 2019; Chung et al., 2022; Cressey et al., 2019; Rice et al., 2018; Tunnicliffe et al., 2014), the convergence of the present findings across conditions suggests that the underlying aetiology of outbursts may be similarly transdiagnostic. The primary limitation of the present study is the inadequate representation of the first-hand perspectives of children and young people, who may provide unique insight into the aetiology of outbursts. Two barriers to participation for children and young people were identified: 1) as the study aimed to be inclusive in the recruitment of caregivers and therefore did not impose eligibility criteria based on the ability

or diagnosis of children and young people, the interview process was not necessarily appropriate for a child or young person's level of understanding or communication; and 2) a child or young person might not feel comfortable recalling or divulging information to researchers about their own outbursts, which could be especially personal or distressing. Therefore, future work can focus on the perspectives of children and young people and implement additional methodologies that can further facilitate their participation (e.g., written responses, framing questions on outbursts from a third-person perspective, or arts-based methods, such as the use of pictorial prompts Mittmann et al., 2021).

In the present study, caregivers and several children and young people with neurodevelopmental conditions shared their perspectives on emotional outbursts and the influence of contextual factors on outburst aetiology. The present findings detail the mechanisms involved in the escalation and manifestation of emotional outbursts across contexts. Furthermore, the results advance our understanding of how perceived comfort and sensory stimuli contribute to outburst aetiology in terms of their moderating effects on these core mechanisms.

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Supplementary Information

Supplementary Table S5.1 Demographic information of participants in each interview

	Caregiver		Child or young person								
Interview number	Relation to child	Gender	Age	Gender	Diagnoses	Schooling or employment	Medication	Access to support	SEN statement or plan	Trauma	Location
1	Parent	F	11	M	ASD, WS	Special school	No	Yes	Yes	No	NA
			8	M	ADHD, anxiety, ASD, DBD	Home education	Yes	Yes	Yes	No	NA
2	Parent	F	12	F	DS, ID	Mainstream school	No	No	Yes	No	UK
3	Parent	F	10	M	Attachment, SPD, LD	Home education	No	No	No	Yes	UK
4	Parent	F	24	M	ADHD, anxiety, CHARGE syndrome, hearing impairment, ID, LD	Special school	No	No	Yes	Yes	NA
5	Parent	F	20	F	DS, hearing impairment, ID	Further education	No	No	Yes	No	UK

	Caregiver			Child or young person						
Interview number	Relation to child	Gender	Age	Gender	Diagnoses	Schooling or employment	Medication	Access to support	SEN statement or plan	Trauma	Location
6	Parent	F	7	F	DS, ID	Mainstream school	No	No	Yes	Yes	UK
7	Parent	F	11	M	CHARGE syndrome	Mainstream school	No	Yes	Yes	No	NA
8	Parents	M + F	7	F	CDLS, hearing impairment, ID	Special school	No	Yes	Yes	No	NA
9	Parents	M + F	8	F	CDLS, ID	Mainstream school	Yes	No	Yes	No	NA
10	Parent	F	22	M	Anxiety, CDLS, ID, LD	Unemployed	No	Yes	Yes	Yes	Other
11	Parent	F	19	F	CHARGE syndrome, hearing impairment, ID	Further education	No	No	Yes	No	NA
12	Parent	M	11	F	ASD, CDLS, hearing impairment, ID	Special school	No	No	Yes	No	Other
13	Parent	F	17	M	CDLS, ID	Mainstream school	No	Yes	No	Yes	NA
14	Parent	F	9	M	CDLS, LD	Mainstream school	No	No	Yes	No	Other

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CHAPTER 6

GENERAL DISCUSSION

Thesis summary

Through a series of four empirical studies, the present thesis evaluated the suitability of measures of emotional outbursts and emotion regulation and developed a framework that accounts for the causal heterogeneity between these two constructs. These studies employed diverse and innovative methodologies which were favoured over other conventional methods based on their suitability in answering the relevant research questions.

The work in Chapter 2 demonstrated that the responder behaviour of children and young people in the Ultimatum Game is consistent with the hypothesised involvement of emotion regulation in decision-making within the paradigm. However, the performance metrics were not found to be associated with trait measures of emotion regulation. Furthermore, choice history was highlighted as a significant determinant of responder behaviour and should therefore be considered in other similar experimental paradigms aiming to index emotion regulation.

In Chapter 3, caregiver responses to the newly developed Emotional Outburst Questionnaire enabled the identification of three patterns of contexts associated with outbursts. These patterns of contexts were independently replicated in Chapter 4 with a culturally distinct sample of caregivers in Brazil. The findings from these two chapters provided a strong foundation for the development of the contextual pathways framework. Furthermore, the validation of the subset of items across the English and Brazilian Portuguese versions of the questionnaire demonstrated the potential utility of this measure in future work.

Through the perspectives of caregivers and some children and young people, the work in Chapter 5 detailed the core mechanisms of outburst escalation and manifestation which cut across contextual pathways. Furthermore, the findings described the pathway-specific mechanisms corresponding to the patterns of contexts identified in the two previous chapters.

Contextual pathways framework

The primary outcome of this body of work was the generation of a theoretical framework for the aetiology of emotional outbursts, which can account for the context-dependence of outbursts through transdiagnostic mechanisms related to emotion dysregulation. Adopting a transdiagnostic approach is a critical step in advancing the field of study, as the present findings demonstrate convergence and overlap across diagnostic groups, which is arguably to be expected of a highly complex phenomenon such as emotional outbursts (Astle et al., 2022). This new and unified approach enables a shift in focus from traditional diagnostic boundaries to individual differences across dynamic processes that may provide more fruitful targets for interventions (Woodcock & Blackwell, 2020). The delivery of pathway-specific interventions that match the needs of a child or young person can be supported by defining the boundary of operation for each pathway and by recognising the inherent intraindividual variability of outbursts such that multiple pathways may apply to one person.

Furthermore, this series of work brought attention to specific populations of children and young people who have rarely been considered in previous research on outbursts (e.g., people who have experienced childhood trauma), which may provide the necessary justification and impetus for future work to adopt this level of inclusion and/or to further

characterise outbursts in these under-represented groups of children and young people. Similarly, work contributing to this framework included the consideration of culture through data collected from caregivers in Brazil, which may provide the motivation for future work to examine the interaction of outbursts and different cultures in further detail.

This framework sets out the core processes involved in the escalation and manifestation of outbursts that are integral to the conceptualisation of outbursts and may facilitate the exploration of mechanisms related to presently unidentified pathways. The moderating effects of perceived comfort and sensory stimuli on these fundamental processes of emotional outbursts provide the theoretical bases for further examination of these relationships. This endeavour may benefit from the inclusion of measures or paradigms that can directly index momentary emotion regulation capacity within contexts that are relevant to the pathways of interest. However, this area remains a challenge in the emotion regulation literature and requires consideration of other factors (e.g., choice history as demonstrated in Chapter 2) and further innovation to identify ecologically valid measures of emotion regulation (Cole et al., 2004; Colombo et al., 2020). Establishing the causal mechanisms of a contextual pathway may provide the rationale to develop new interventions and/or to adapt existing interventions targeting those mechanisms relevant to that pathway. For example, aspects of compassion focused therapy that aim to increase feelings of safety may be especially pertinent to outbursts related to perceived comfort or discomfort, whilst interventions for sensory processing difficulties from the field of occupational therapy may be effective in managing sensory-related outbursts (e.g., Dunn, 2007; Gilbert, 2014).

Much of the present framework focuses on informing the development of preventive strategies prior to the manifestation of outbursts, whereas relatively little information is available for the development of reactive strategies that may be effective during the peak of escalation to reduce the severity and/or duration of outbursts. This disparity underscores a clear gap in our current understanding of processes involved in outburst de-escalation, both in terms of the natural chronology of outbursts, and the mechanisms of action for interventions that can de-escalate outbursts. Although preventive approaches that aim to resolve the underlying causes of outbursts are undoubtedly important, they invariably have limited efficacy in managing outbursts that occur suddenly or with no apparent trigger. Thus, the effective management of a child or young person's emotional outbursts across contexts may require a repertoire of pathway-specific preventive strategies and reactive interventions (National Institute for Health and Care Excellence, 2015).

Uses of the Emotional Outburst Questionnaire

At present, the Emotional Outburst Questionnaire can be used to provide a comprehensive account of a person's difficulties with outbursts, which may be informative for the formulation of a support plan that takes into consideration the intraindividual variability of outbursts. Furthermore, the questionnaire may help caregivers to systematically reflect on outbursts, a process which some caregivers in the present studies found to be especially valuable for developing their own understanding of their children's outbursts. Potential future uses of the Emotional Outburst Questionnaire include the classification of new responses using existing data regarding the patterns of contexts associated with outbursts (see Limitations within this chapter) and the estimation of outburst severity based on other

characteristics of outbursts (e.g., behaviours, frequency, duration; see Future directions within this chapter).

Limitations

The primary limitations of the present studies have been acknowledged within each corresponding chapter, but there were further shortcomings that were outside of the scope of the studies but should nevertheless be discussed in this chapter.

The work in Chapter 2 was constrained by the design and sample availability of the original study in which the data were collected. Specifically, the inclusion of children and young people balanced across age groups for each Ultimatum Game paradigm would have allowed for a more robust evaluation of the effects of paradigm modifications that could have accounted for the influence of age. Furthermore, the use of three distinct versions of the Ultimatum Game precluded the pooling of data across the sample of children and young people, which could have otherwise offset concerns around insufficient sample size at the trial level (Chen et al., 2022). Exploration of the effects of paradigm modifications within a single version of the game would have remained possible by altering the block design such that participants completed multiple blocks of trials, with each block differing in the modifications it contained. However, such a design with a higher number of trials would have to consider the potential impact of participant fatigue in later trials (Lorist et al., 2000).

Although caregivers and professionals provided feedback on the Emotional Outburst Questionnaire during the later stages of development, the measure would have benefited from further integration of stakeholder input at all stages of development to bolster the content validity of the questionnaire (Wiering et al., 2017). In the work evaluating the

Emotional Outburst Questionnaire in Chapter 3, there were recruitment challenges that prevented more nuanced analyses of the potential effects of diagnosis on the study findings. Indeed, the aggregation of resources through collaborations with researchers from other institutions might have enabled a wider reach in terms of recruitment.

Whilst the primary findings in Chapter 4 contributed to the validation of the Emotional Outburst Questionnaire, the inability to reliably classify new data using existing cluster centroids presents a methodological barrier against the utility of the measure, which may require larger datasets and more advanced procedures to overcome (as detailed in Chapter 4). Work on this issue will be critical in ensuring that children and young people who experience outbursts in certain patterns of contexts can be reliably identified for screening in research and clinical settings. Even if quantitative classification is found to be unfeasible, the qualitative differences between the pathways may be operationalised with methods that incorporate input from stakeholders (e.g., the Delphi method; Gómez et al., 2015; Hasson et al., 2000).

In Chapter 5, the implementation of a grounded theory approach was constrained by the resources available for the study, such that there was no opportunity for the resampling of interviewees to obtain further information on specific lines of inquiry. This limitation impacted the degree of theoretical sampling that was achieved in the study, but theoretical sampling remained possible through engagement and reengagement with the existing data throughout theory development (Timonen et al., 2018). Furthermore, the generalisability of the emergent theory should be tested in additional samples and in other cultural contexts.

Future directions

In addition to the future directions suggested above relating to outburst aetiology, the data collected in this thesis present further prospects for advancing our understanding of other facets of emotional outbursts.

Future work could capitalise on the available data for other aspects of the Emotional Outburst Questionnaire that were not analysed by the studies in Chapters 3 and 4. A specific area of focus should be to identify items within the questionnaire that can index the overall severity of emotional outbursts in children and young people. Indeed, this type of research has been conducted in relation to tantrums experienced by toddlers, whereby factors such as the duration of episodes have been established as indicators of clinical significance (Belden et al., 2008; Wakschlag et al., 2014). The use of item response theory (Samejima, 1969) to calibrate the questionnaire data across a latent construct of outburst severity would be a suitable prospect, as items with high discriminatory power at different levels of outburst severity could be identified and collated into a short-form questionnaire for screening overall severity. Given the large sample size requirements for such analysis (Jiang et al., 2016), the pooling of data from the work in Chapters 3 and 4 might be sufficient, and differential item functioning analysis (Teresi & Fleishman, 2007) could be additionally employed to assess potential differences between the two samples in the primary analysis. This line of research would be valuable for the development of interventions as there is currently a lack of valid outcome measures for outbursts that are sensitive to change, which was one of the primary motivations for the development of the Emotional Outburst Questionnaire.

Information regarding the impact of emotional outbursts on the wellbeing of children and young people and those around them were collected as part of the interviews in Chapter 5, which could be informative in highlighting the unmet needs of families. Furthermore, understanding the ways in which families are impacted by outbursts could enable the identification of outcome measures related to specific aspects of wellbeing or quality of life that would be most appropriate in assessing the effects of potential interventions. For example, previous studies have identified that emotional outbursts are particularly distressing for caregivers to witness and manage (Lowe & Felce, 1995; Montaque et al., 2018; S. Ryan, 2010). Therefore, one of the desired outcomes of an intervention for outbursts should be the reduction in caregiver stress, which could be indexed by measures such as the Emotional Wellbeing subscale in the Family Quality of Life Scale (Hoffman et al., 2006). Whilst the development of interventions that aim to directly reduce the frequency and/or severity of outbursts should remain the primary focus and long-term goal, additional research should identify how caregivers could be supported in the short- and medium-term, as the relationship between emotional outbursts and the caregiver's emotional state as specified in Chapter 5 suggests that additional support for caregivers may indirectly benefit the baseline regulatory capacity of children and young people, thereby reducing the propensity for emotional outbursts. Furthermore, in a review of existing evidence around psychological support for caregivers, the National Institute for Health and Care Excellence (2020) in the United Kingdom has reported that these interventions can increase the quality of care provided by caregivers, which may further positively impact the management of emotional outbursts.

A priority in this area of research should focus on wider public outreach and the dissemination of key findings, which may address three of the unmet needs of families that were identified in this thesis. Firstly, the work in Chapter 3 identified the lack of availability of effective support for a large proportion of families. Improved access to information regarding the aetiology of outbursts may serve as a form of early intervention for caregivers of children and young people who have recently started experiencing outbursts, as the information may enable caregivers to better identify the antecedents and potential causes of their children's outbursts. Secondly, it was found in Chapter 5 that the services supporting children and young people who mask their outbursts are sometimes unaware of the children and young people's underlying difficulties, which can conceivably further limit the access to support for families. In addition to ensuring that the perspectives of caregivers are acknowledged by the services supporting children and young people (as highlighted in Chapter 5 and in the wider literature on challenging behaviour; e.g., C. Ryan & Quinlan, 2018; Sheehan et al., 2018), increasing access to information on outbursts for these services may further help them identify and implement appropriate forms of support. Thirdly, both Chapters 3 and 5 drew attention to the caregivers' emphasis on understanding an emotional outburst as a discrete phenomenon that is out of the child or young person's control rather than deliberate misbehaviour that may be recognised by others as a tantrum. Wider dissemination of the present research and use of more appropriate terminology in clinical and research contexts may facilitate the shift in the public perception of outbursts, thereby reducing the stigma that families may experience and increasing their quality of life (Kinnear et al., 2016).

Conclusion

This thesis represents the initial efforts to establish and develop an aetiological framework of emotional outbursts in children and young people across context-dependent and transdiagnostic pathways. Through this body of work, three pathways relating to distinct patterns of contexts were identified and characterised in terms of their moderating effects on the escalation and manifestation of emotional outbursts. The introduction of this novel framework presents a clear direction for the expansion of both established and presently unidentified pathways. Outside of the aetiology of emotional outbursts, the thesis identified additional avenues of research that can further utilise the data made available through the present work. Overall, it is hoped that this thesis, along with the future research that may stem from it, will contribute positively to the lives of children and young people who experience emotional outbursts.

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APPENDICES

Appendix 1 The Emotional Outburst Questionnaire

The Emotional Outburst Questionnaire

The term "*emotional outburst*" refers to a highly emotional or explosive episode, where at least one of the behaviours listed below (items 2-23) is displayed. Emotional outbursts may also be known as "*meltdowns*", "*crisis*", "*behavioural breakdown",* "*blips*", "*rages*", "*temper outbursts*", "*tantrums*", or "*tempers*".

In this questionnaire, we want you to think about the **most severe** and **least severe** emotional outbursts **within the past month** that the individual you care for has displayed and the characteristics associated with each type of emotional outburst, such as behaviours, frequency, and duration. In terms of the **severity** of emotional outbursts, we are referring to how disruptive and negatively impactful they are to the person and/or those around them **at the time** of the emotional outburst.

If you feel that the **severity** of emotional outbursts is always the same, please answer the questions relating to the **most severe** type. We recognise that some questions may be difficult to answer, as emotional outbursts can vary greatly depending on the context. However, please try to give an average for these questions, as this will help us to better understand emotional outbursts over a range of contexts.

First, we would like you to consider the **most severe** emotional outbursts that the individual you care for has displayed **within the past month**.

1	Please list **up to 20 words** to describe what distinguishes the **most severe** emotional outbursts. *(e.g. physically aggressive, screaming, at least an hour)*	

Please indicate your answer for each of the following items by ticking the appropriate box (☐).

During the **most severe** emotional outbursts, how often does the individual you care for display the following behaviours?		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
2	Behavioural indicators of emotion *(e.g. angry or annoyed facial expressions, crying, signs of distress, whining)*	☐	☐	☐

3	Mild verbal aggression *(e.g. insults, name-calling, screaming, shouting, swearing)*	☐	☐	☐
4	Extreme verbal aggression *(e.g. threats of violence)*	☐	☐	☐
5	Non-speech vocalisations (*e.g. making sounds or noises*)	☐	☐	☐
6	Mild aggression towards property *(e.g. defacing walls, ripping clothing, slamming door, throwing objects down)*	☐	☐	☐
7	Extreme aggression towards property *(e.g. breaking objects, smashing windows, throwing objects dangerously)*	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
8	Mild physical aggression towards others **without physical injury** *(e.g. biting, grabbing, hitting, kicking, pulling hair, pushing, scratching, spitting, throwing objects at people)*	☐	☐	☐
9	Extreme physical aggression towards others **with physical injury** *(e.g. biting, grabbing, hitting, kicking, pulling hair, pushing, scratching, throwing objects at people)*	☐	☐	☐
10	Mild self-injurious behaviours **without serious injury** (no cuts, bruises, burns, etc) *(e.g. banging head, biting, hitting self, hitting wall, holding breath, picking skin, pulling hair)*	☐	☐	☐

11	Extreme self-injurious behaviours **with serious injury** *(e.g. banging head, biting, hitting self, hitting wall, picking skin, picking rectum, pulling hair)*	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
12	Talking to self & others *(e.g. agitated talking, repetitive speech, self-deprecating speech)*	☐	☐	☐
13	Increased motor activity *(e.g. flailing arms, non-directed kicking, pacing, repetitive behaviours, rushing about, stamping feet, tics)*	☐	☐	☐
14	Increased physiological arousal *(e.g. red face, salivating, sweating)*	☐	☐	☐
15	Avoidance *(e.g. dropping to floor, going to room, leaving situation, running away)*	☐	☐	☐
16	Removing items of clothing	☐	☐	☐
17	Defecation or urination	☐	☐	☐
18	Contextually inappropriate sexual behaviours	☐	☐	☐
19	Ignoring or not talking to certain people	☐	☐	☐
20	Not reacting to things going on around them	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)

21	Food-related behaviours (*e.g. grabbing, pleading for, seeking, or stealing food*)	☐	☐	☐
22	Making themselves sick (*e.g. retching or vomiting*)	☐	☐	☐
23	Unusual behaviours	☐	☐	☐

Advice and support around protecting the individual you care for is available via the NSPCC, Papyrus, or Samaritans.

Website: nspcc.org.uk
Email: help@nspcc.org.uk
Telephone: 0808 800 5000

Website: papyrus-uk.org
Email: pat@papyrus-uk.org
Telephone: 0800 068 4141

Website: samaritans.org
Email: jo@samaritans.org
Telephone: 116 123

24	How often do the **most severe** emotional outbursts occur?	☐ Never	☐ Less than once a month	☐ Once a month	☐ 2-3 times a month	☐ Once a week	☐ 2-3 times a week	☐ Once a day	☐ More than once a day
25	How long do the **most severe** emotional outbursts last?	☐ Less than 5 minutes	☐ 5-15 minutes	☐ 15-30 minutes	☐ 30 minutes to 1 hour	☐ 1-2 hours	☐ 2 hours to a day	☐ A day or more	
26	How angry or upset does the person get during the **most severe** emotional outbursts?	☐ 1 Not angry or upset at all	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7 As angry or upset as I have ever seen them	
27	Compared to baseline behaviour, how much eye contact does the person seek from you during the **most severe** emotional outbursts?	☐ Less than baseline		☐ Same as baseline				☐ More than baseline	

28	How long does it take for the person to recover from the **most severe** emotional outbursts (i.e. from the end of emotional outburst behaviours to when behaviour is back to normal)?	☐ Less than 5 minutes	☐ 5-15 minutes	☐ 15-30 minutes	☐ 30 minutes to 1 hour	☐ 1-2 hours	☐ 2 hours to a day	☐ A day or more

Now, we would like you to consider the **least severe** emotional outbursts that the individual you care for has displayed **within the past month**, that nevertheless disrupt and negatively impact them and/or those around them. We are referring to episodes that are different from the person's normal or baseline behaviour. The term "*emotional outburst*" refers to a highly emotional or explosive episode, where at least one of the behaviours listed above (items 2-23) is displayed. Emotional outbursts may also be known as "*meltdowns*", "*crisis*", "*behavioural breakdown",* "*blips*", "*rages*", "*temper outbursts*", "*tantrums*", or "*tempers*".

If you feel that the **severity** of emotional outbursts is always the same, please tick the 'Not applicable' box below and continue from item 57.

29	Please list **up to 20 words** to describe what distinguishes the **least severe** emotional outbursts. *(e.g. crying, red face, no more than 5 minutes)*	☐ Not applicable

Please indicate your answer for each of the following items by ticking the appropriate box (☐).

During the **least severe** emotional outbursts, how often do they display the following behaviours?		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
30	Behavioural indicators of emotion *(e.g. angry or annoyed facial expressions, crying, signs of distress, whining)*	☐	☐	☐
31	Mild verbal aggression *(e.g. insults, name-calling, screaming, shouting, swearing)*	☐	☐	☐
32	Extreme verbal aggression *(e.g. threats of violence)*	☐	☐	☐

33	Non-speech vocalisations (*e.g. making sounds or noises*)	☐	☐	☐
34	Mild aggression towards property *(e.g. defacing walls, ripping clothing, slamming door, throwing objects down)*	☐	☐	☐
35	Extreme aggression towards property *(e.g. breaking objects, smashing windows, throwing objects dangerously)*	☐	☐	☐
36	Mild physical aggression towards others **without physical injury** *(e.g. biting, grabbing, hitting, kicking, pulling hair, pushing, scratching, spitting, throwing objects at people)*	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
37	Extreme physical aggression towards others **with physical injury** *(e.g. biting, grabbing, hitting, kicking, pulling hair, pushing, scratching, throwing objects at people)*	☐	☐	☐
38	Mild self-injurious behaviours **without serious injury** (no cuts, bruises, burns, etc) *(e.g. banging head, biting, hitting self, hitting wall, holding breath, picking skin, pulling hair)*	☐	☐	☐
39	Extreme self-injurious behaviours **with serious**	☐	☐	☐

	injury *(e.g. banging head, biting, hitting self, hitting wall, picking skin, picking rectum, pulling hair)*			
40	Talking to self & others *(e.g. agitated talking, repetitive speech, self-deprecating speech)*	☐	☐	☐
41	Increased motor activity *(e.g. flailing arms, non-directed kicking, pacing, repetitive behaviours, rushing about, stamping feet, tics)*	☐	☐	☐
42	Increased physiological arousal *(e.g. red face, salivating, sweating)*	☐	☐	☐
43	Avoidance *(e.g. dropping to floor, going to room, leaving situation, running away)*	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
44	Removing items of clothing	☐	☐	☐
45	Defecation or urination	☐	☐	☐
46	Contextually inappropriate sexual behaviours	☐	☐	☐
47	Ignoring or not talking to certain people	☐	☐	☐
48	Not reacting to things going on around them	☐	☐	☐
49	Food-related behaviours (*e.g. grabbing, pleading for, seeking, or stealing food*)	☐	☐	☐

		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
50	Making themselves sick (*e.g. retching or vomiting*)	☐	☐	☐
51	Unusual behaviours	☐	☐	☐

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Website: nspcc.org.uk
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Website: papyrus-uk.org
Email: pat@papyrus-uk.org
Telephone: 0800 068 4141

Website: samaritans.org
Email: jo@samaritans.org
Telephone: 116 123

52	How often do the **least severe** emotional outbursts occur?	☐ Never	☐ Less than once a month	☐ Once a month	☐ 2-3 times a month	☐ Once a week	☐ 2-3 times a week	☐ Once a day	☐ More than once a day
53	How long do the **least severe** emotional outbursts last?	☐ Less than 5 minutes	☐ 5-15 minutes	☐ 15-30 minutes	☐ 30 minutes to 1 hour		☐ 1-2 hours	☐ 2 hours to a day	☐ A day or more
54	How angry or upset does person get during the **least severe** emotional outbursts?	☐ 1 Not angry or upset at all		☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7 As angry or upset as I have ever seen them
55	Compared to baseline behaviour, how much eye contact does the person seek from you during the **least severe** emotional outbursts?	☐ Less than baseline			☐ Same as baseline			☐ More than baseline	

56	How long does it take for person to recover from the **least severe** emotional outbursts (i.e. from the end of emotional outburst behaviours to when behaviour is back to normal)?	☐ Less than 5 minutes	☐ 5-15 minutes	☐ 15-30 minutes	☐ 30 minutes to 1 hour	☐ 1-2 hours	☐ 2 hours to a day	☐ A day or more

We would like you to consider **in general, all emotional outbursts** the individual you care for has displayed **within the past month**.

Please indicate your answer for each item by ticking the appropriate box (☐).

57	How often do emotional outbursts occur?	☐ Never	☐ Less than once a month	☐ Once a month	☐ 2-3 times a month	☐ Once a week	☐ 2-3 times a week	☐ Once a day	☐ More than once a day

When the individual you care for is in the following places, how often do emotional outbursts occur?		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
58	A place that makes them feel safe	☐	☐	☐
59	A place that makes them feel unsafe	☐	☐	☐
60	A place that they are familiar with *(e.g. at a relative/friend's house)*	☐	☐	☐
61	A place that they are unfamiliar with *(e.g. whilst on holiday away from home)*	☐	☐	☐
62	A place that they feel is private *(e.g. in their room)*	☐	☐	☐
63	A place that they feel is public *(e.g. at a shop)*	☐	☐	☐

When the individual you care for is with the following people, how often do emotional outbursts occur?		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
64	Someone that makes them feel safe (*e.g. a parent/caregiver)*	☐	☐	☐
65	Someone that makes them feel unsafe *(e.g. a dentist)*	☐	☐	☐
66	Someone familiar *(e.g. a teacher)*	☐	☐	☐
67	Someone unfamiliar *(e.g. a cashier at a shop)*	☐	☐	☐

68	Someone they like	☐	☐	☐
69	Someone they dislike	☐	☐	☐
70	Someone they are jealous of	☐	☐	☐

When the individual you care for is in the following states, how often do emotional outbursts occur?		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
71	Tired	☐	☐	☐
72	Hungry or thirsty	☐	☐	☐
73	Consumed too much of one type of food or drink *(e.g. caffeine)*	☐	☐	☐
74	Illness	☐	☐	☐
75	In pain	☐	☐	☐
76	In a bad mood or having a bad day	☐	☐	☐
When the following trigger events occur, how often do they lead to an emotional outburst?		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
77	Planned transition from one activity to another	☐	☐	☐
78	Change in own routine	☐	☐	☐
79	Change in another's routine	☐	☐	☐
80	Change in expectation	☐	☐	☐
81	Being fixated on a thought or idea	☐	☐	☐
82	Specific phobia or fear	☐	☐	☐
83	Food-related triggers	☐	☐	☐
84	Concerns for own property (e.g. losing something or worried about losing something)	☐	☐	☐

		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
85	Not being given or not being able to do something the person wants	☐	☐	☐
86	Having to wait before being given or being able to do something	☐	☐	☐
87	Being asked to do something the person may or may not want to do	☐	☐	☐
88	Doing a boring task	☐	☐	☐
89	Doing a difficult task	☐	☐	☐
90	Doing a repetitive task	☐	☐	☐
		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
91	Doing a new task	☐	☐	☐
92	Under time pressure (e.g. getting ready in the morning)	☐	☐	☐
93	Disagreement with others	☐	☐	☐
94	Being told off, criticised, or accused of making a mistake	☐	☐	☐
95	Being teased	☐	☐	☐
96	Being apart from parent(s)/caregiver	☐	☐	☐
97	Not receiving enough attention or being ignored	☐	☐	☐
98	Receiving too much attention	☐	☐	☐
99	Feeling of being treated unfairly	☐	☐	☐
100	Someone not understanding the individual you care for	☐	☐	☐
101	The individual you care for not understanding someone else	☐	☐	☐

		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
102	Not understanding what is going on	☐	☐	☐
103	Receiving conflicting information	☐	☐	☐
104	Light is too bright	☐	☐	☐
105	Sudden or loud noises	☐	☐	☐
106	Temperature is too hot or too cold	☐	☐	☐
107	Particular smells or strong smells	☐	☐	☐
108	Touch-related over-sensitivity (e.g. uncomfortable seat or sudden touch)	☐	☐	☐
109	Other sensory-related triggers Specify:	☐	☐	☐
110	Medication side-effect	☐	☐	☐
111	Mood of parent/caregiver	☐	☐	☐
112	No reason/out of the blue	☐	☐	☐
113	How confident are you in your answers above (items 77-112) relating to the triggers that lead to emotional outbursts?	Not confident ☐	Quite confident ☐	Very confident ☐

How successful are the following management strategies in calming emotional outbursts of the individual you care for?		Not applicable/never/rarely (0-3 times out of 10)	Sometimes (4-6 times out of 10)	Often/always (7-10 times out of 10)
114	Physical or verbal comfort	☐	☐	☐
115	Discussion or persuasion	☐	☐	☐
116	Calming or relaxation strategies	☐	☐	☐
117	Giving them what they want	☐	☐	☐
118	Visual aids	☐	☐	☐

119	Punishment or threat of punishment	☐	☐	☐
120	Negotiation	☐	☐	☐
121	Actively ignoring behaviour	☐	☐	☐
122	Moving them or others from situation	☐	☐	☐
123	Distraction	☐	☐	☐
124	Showing empathy	☐	☐	☐
How often does the individual you care for display the following behaviours **after** emotional outbursts?		Not applicable/never/rarely (0-3 times out of 10 outbursts)	Sometimes (4-6 times out of 10 outbursts)	Often/always (7-10 times out of 10 outbursts)
125	Apologising	☐	☐	☐
126	Blaming others	☐	☐	☐
127	Seeking reassurance or comfort	☐	☐	☐
128	Appearing withdrawn	☐	☐	☐
129	Staying in a bad mood	☐	☐	☐
130	Feeling anxious	☐	☐	☐
131	Feeling sad	☐	☐	☐
132	Behaving as if nothing had happened	☐	☐	☐
133	How often are you there to witness the emotional outbursts when they occur?	Never/rarely (0-3 times out of 10 outbursts) ☐	Sometimes (4-6 times out of 10 outbursts) ☐	Often/always (7-10 times out of 10 outbursts) ☐

Appendix 2 Caregiver interview schedule

Introduction

[Define emotional outbursts. Ask caregiver to focus on outbursts prior to the COVID-19 pandemic. Mention that there will be a section in the interview where we can focus on the impact of the lockdown on the child/young person.]

1. Based on feedback from parents and carers, we are now using the term 'emotional outburst' instead of 'temper outburst'. What are your thoughts on the term 'emotional outburst'?
    a. Prompt: Do you think it is appropriate?

2. Is there a term you would prefer to use throughout this interview?
    a. Could you describe why you prefer this term?

Impact

3. How do outbursts impact [child's name]'s wellbeing?
    a. Could you describe the most impactful aspects of outbursts?
    b. Prompts:
        i. Frequency of outbursts
        ii. Duration of outbursts
        iii. Time for [child's name] to recover from outbursts
        iv. Behaviours displayed during outbursts – e.g., verbal aggression, physical aggression, destruction of property, self-injury
    c. Do outbursts impact the wellbeing of people around [child's name] in the same way?
        i. If not, could you describe how it is different?
    d. The long-term goal of our research is to develop intervention strategies around outbursts. Could you describe how an intervention should change [child's name]'s outbursts so that you would notice an improvement?

Contexts

4. What are the most important triggers for [child's name]'s outbursts?

5. What are the most important background factors or settings that might make emotional outbursts more likely to happen?
    a. Prompt: Background factors might include where they are, who they are with, and how they are feeling.

These triggers and background factors may be especially important when we think about why outbursts happen and what we could do to intervene.

6. Does the safety of the environment affect [child's name]'s outbursts? [Continue onto next question if not applicable.]
    a. What makes [child's name] more likely to have outbursts when they feel [safe compared to when they feel threatened or do not feel safe (or vice versa)]?
        i. Prompts:
            1. How does safety cause [child's name] to react differently to potential triggers?
            2. How are potential triggers dealt with in different settings (e.g., at home vs in public)?
    b. Can you think of times when [child's name] feel [safe or threatened] and they do not have an outburst, even though you expected an outburst to happen?
        i. [If yes] How might the way [child's name] processes their thoughts or emotions be related to whether they have an outburst or not?
            1. Prompts:
                a. Ability to cope or communicate
                b. Motivation to reach a desired goal
        ii. [If no] How might the way [child's name] processes their thoughts or emotions be related to them always having an outburst when they [feel safe/feel threatened or do not feel safe]?
            1. Prompts:
                a. Ability to cope or communicate
                b. Motivation to reach a desired goal

7. Does sensory sensitivity affect [child's name]'s outbursts? [Continue onto next question if not applicable.]
    a. Could you describe how [child's name]'s sensory sensitivity is related to their outbursts?
        i. Prompts:
            1. Different senses
            2. Hyper- vs hyposensitivity
                a. How does [child's name]'s [hypersensitivity/hyposensitivity] lead to outbursts?

            b. [If hyposensitive] How does a calm environment affect whether [child's name] has an outburst or not?
        3. Reaction to self-stimulation vs external stimulation
        4. Effect on other triggers and settings
    b. Can you think of times when [child's name] is [facing related trigger] and they do not have an outburst?
        i. [If yes] How might the way [child's name] processes their thoughts or emotions be related to whether they have an outburst or not?
        ii. [If no] How might the way [child's name] processes their thoughts or emotions be related to them always having an outburst [related to trigger]?

8. Do outbursts happen when demands are placed on [child's name] or when [child's name] does not get their way? [Continue onto next question if not applicable. If none of the pathways are applicable, prompt with other triggers mentioned in questions 4 and 5.]
    a. Can you think of times when [child's name] is [facing related trigger] and they do not have an outburst?
        i. [If yes] How might the way [child's name] processes their thoughts or emotions be related to whether they have an outburst or not?
            1. Prompts:
                a. Ability to cope or communicate
                b. Motivation to reach a desired goal
        ii. [If no] How might the way [child's name] processes their thoughts or emotions be related to them always having an outburst [related to trigger]?
            1. Prompts:
                a. Ability to cope or communicate
                b. Motivation to reach a desired goal
    b. What happens if the trigger is removed?
        i. [If outburst is maintained] Prompt why
        ii. [If outburst ends] Prompt how [child's name] is able to stop their outburst
    c. Does [child's name] react negatively to [related trigger] in other ways aside from outbursts?
        i. [If yes] Prompt how the situations differ
        ii. [If no] Prompt why not

9. Thinking about the types of outbursts we have discussed, is there anything else that you think is important to discuss?

10. Could you suggest how we could help [child's name] to reduce the difficulties they have with outbursts?

Experiment design

We currently face a challenge when thinking about how we can directly measure and observe emotional outbursts. Short periods of observation may be ineffective for people who have less frequent outbursts (e.g., once a day). We have also tried asking parents to keep a diary of emotional outbursts, but this can be very demanding on families and some parents have explained that outbursts happen more often than they can report. We have some ideas on how we might overcome these barriers to directly look at these different factors and how they are related to emotional outbursts.

The general idea would be to have one or two researchers observe and record a person's outbursts in real life throughout the day, over multiple days. We might use video-recording, audio-recording, or recording of their body's response, such as heart rate. During the observations, we could modify the environment to try to change how likely outbursts happen. The changes we make would depend on the person's related triggers and settings.

11. What are your thoughts on this kind of experiment?
    a. What factors should we consider to make sure that this kind of experiment is suitable for families?
    b. Prompts:
        i. Feasibility and barriers to overcome
        ii. Acceptability of triggering outbursts
        iii. Safety of observers
        iv. Any other ideas

COVID-19 impact

12. How is the current lockdown affecting [child's name]'s wellbeing?

13. How is the current lockdown affecting [child's name]'s outbursts?

a. Prompts:
    i. Frequency of outbursts
    ii. Change in response to previous triggers?
    iii. New triggers
    iv. How are these changes related to pathways that were previously discussed?

Closing

14. Apart from triggers and settings, is there anything you would like to mention which we haven't considered?

15. Is there anything you'd like to ask me before we finish?

Appendix 3 Young person interview schedule

Introduction

1. Thinking back to the last time when you had an outburst, could you describe what happened?
    a. Is this what normally happens when you have an outburst?
    [If yes, continue to next question. If no, prompt for a typical outburst.]

        i. Prompt: What normally happens when you have an outburst?

Impact

2. Could you describe how outbursts make you feel?
    a. Prompts:
        i. Could you describe how you feel after an outburst?
        ii. What about an outburst makes you feel this way?

3. Could you describe how outbursts make people around you feel?
    a. Prompts:
        i. Family
        ii. Friends

Contexts

4. When do outbursts normally happen?
    a. Prompt for triggers and settings:
        i. Where do outbursts happen?
        ii. Who is with you when outbursts happen?
        iii. What happens that causes an outburst?

5. Could you describe how [setting/trigger] makes you feel?

6. What could we do to make you feel better about [outbursts related to setting/trigger]?

COVID-19 impact

7. How do you feel about the current lockdown?

8. How is the current lockdown affecting your outbursts?
    b. Prompts:
        i. Frequency of outbursts
        ii. Change in response to previous triggers?
        iii. New triggers

Closing

9. Is there anything else about outbursts that you would like to talk about?

10. Is there anything you'd like to ask me before we finish?