





Regular Article

Childhood abuse and neglect and profiles of adult emotion dynamics

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Abstract

Childhood maltreatment (CM) is experienced by ~40% of all children at major personal and societal costs. The divergent associations between emotional, physical, and sexual abuse or neglect in childhood and differences in adult emotional functioning and regulation were examined in terms of daily emotion intensity, variability, instability, inertia, and diversity, reported over 30 days by 290 Dutch aged 19–73. Participants described their abuse/neglect experiences retrospectively using the Childhood Trauma Questionnaire (CTQ). Dissecting CM effects on adult emotion dynamics may inform theories on the ontogenesis and functioning of emotions, on effects of abuse and neglect, to better understand (dys)functional emotional development, and to prevent their adverse sequelae. Structural equation models (SEM) showed that most types of CM were associated with specific patterns of emotion dynamics, and only emotional abuse had no unique effects on the emotional dynamic indices. Emotional neglect was associated with most measures of emotion dynamics (i.e., less intense, variable, unstable, and diverse emotions). Sexual abuse associated with increases and physical neglect decreases in negative affect variability and instability. Physical abuse was associated with inertia but with a small effect size. Social contact frequency did not mediate much of the relationship between CM types and emotion dynamics.

Keywords: physical abuse; emotional neglect; physical neglect; emotional abuse; EMA

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Introduction

Childhood maltreatment (CM) is a common experience reported by ~40% of people around the world (Stoltenborgh et al., 2014). European community estimates of emotional neglect (~18%) and abuse (~29%), physical neglect (~16%) and abuse (~23%), and sexual abuse (~10%) identify these five types of CM as a key societal issue (e.g., Gilbert et al., 2009; Sethi et al., 2013). Childhood maltreatment compromises children's health, development, and dignity, which can have drastic downstream consequences, including heightened risk of developing depression, suicidality, obesity, and substance abuse (psychological consequences), as well as heart disease, cancer, stroke, diabetes, and inflammation (somatic consequences), which are the leading causes of death and disability worldwide, and convey a major personal, financial, and societal burden (Coelho et al., 2014; Cuijpers et al., 2011; Hughes et al., 2021; Sethi et al., 2013; World Health Organization, 2006). One major explanatory mechanism that may link CM to health outcomes is emotion (dys)functioning (e.g., Sheppes et al., 2015).

The World Health Organization (2006) defined childhood maltreatment as different types of abuse, neglect, and exploitation of children by a caretaker or close family member (>80% of all instances) or authority agent, friends, strangers, or health care workers (Gilbert et al., 2009; Scher et al., 2004). There are practical

differences between CM types, such as the signs of physical abuse being typically visible (e.g., bruising, scratches, burns, scars), whereas emotional and sexual abuse are largely out of sight, and rely on the child's statement (see Table 1). Partly, therefore, there may also be grave underreporting of specific CM types (Gilbert et al., 2009). Hence, we should be careful when comparing CM types, but also examine potential unique patterns of emotion dynamics, as different types of CM are known to increase the risk of specific types of adult psychopathology and physical health outcomes (Eilers et al., 2023; Harms et al., 2019; Norman et al., 2012; Teicher & Samson, 2013; Waxman et al., 2014), and to play different roles in domestic violence and crime (Dong et al., 2004).

CM is thought to disrupt emotional development, functioning, and regulation (Gruhn & Compas, 2020; Young & Widom, 2014), although research examining emotion functioning of CM survivors in daily life is scarce. Victims of prolonged interpersonal trauma early in the life cycle show an increased risk of problems with affect and impulse regulation, memory, attention, self-perception, interpersonal relations, somatization, and systems of meaning (Gruhn & Compas, 2020; van der Kolk et al., 2005). However, little is known about potential differential associations between the type of CM and emotion functioning in daily life. In this study, we therefore explore how different types of abuse and neglect are associated with five key parameters of emotional change in daily life; namely, emotional intensity, variability, instability, inertia, and diversity, and each dynamic measure is defined and described in Table 2.

A deeper understanding of differential CM effects on adult emotion dynamics may inform theories on the ontogenesis and

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Table 1. Different types of childhood maltreatment (CM) and observed associations with adult affect intensity and emotion dynamics and functioning

		PA	NA	Emotion Dynamics	Emotion Functioning
Total CM		-- ^{a,j,k}	++ ^{i,k}	Higher variability of PA and NA ^k	Dysregulation, ^{b, n} Higher NA intensity after daily stress. ^j
Abuse	PA and/or SA and/or EA combined. Prime examples are verbal abuse, humiliation, and acts that scare or terrorize a child.				Lower experienced intensity response to negative pictures and higher intensity to positive than non abused. ^f
Neglect	PN and EN combined, primarily inadequate health care, supervision, and protection from hazards, and deprivation of basic needs (clothing/food) and inattentiveness to a child's emotional and development needs.				Lower sensitivity to affect words. ^b Lower positive picture recognition. ^d Pictures have no effect on emotional intensity. ^f
Sexual abuse (SA)	Unwanted and/or coercive (attempted) sexual contact and exposure to age-inappropriate sexual material or environments, or sexual exploitation. A dependent, developmentally immature child/adolescent is exposed to sexual activities which they do not fully comprehend, for which they are unable to give consent, and/or that violate the social taboos or family roles.				Positive pictures recognition bias. ^d Impulse control. ^c
Physical abuse (PA)	Actual or attempted infliction of physical pain with or without use of an object or weapon and including use of severe corporal punishment. Examples include beating, shaking, choking, slapping, biting, and throwing objects.				Less accuracy in neutral picture recognition. ^d
Emotional abuse (EA)	Acts of threat against a minor child that caused or could have caused conduct, cognitive, affective or other mental disturbance, such as verbal abuse, excessive demands on a child's performance that may lead to negative self-image and disturbed behavior. Examples include disregard for a child's requests or needs and manipulation of emotions, e.g., withholding affection, intentional social deprivation, intimidation/threats, or gaslighting.	-- ^l	++ ^l		Dysregulation, i.e., behavior control difficulties in response to NA. ^c Response focused difficulties, i.e., behavioral control in response to NA, deficiencies in regulation strategies. ^g Dysregulation – multiple types. ^e
Physical neglect (PN)	Failure to provide for a child's basic survival needs, such as nutrition, clothing, shelter, hygiene, and medical care (e.g., caries). Physical neglect may also involve inadequate supervision of a child and other forms of reckless disregard of the child's safety and welfare, such as seeking needed medical care.				
Emotional neglect (EN)	Acts of deprivation against a minor child that caused or could have caused conduct, cognitive, affective or other mental disturbance, such as a failure to provide basic emotional and psychological needs. One example is failure of parents to arrange appropriate education or knowingly permitting maladaptive behavior, failure in providing support, warmth.	-- ^{h*}			Antecedent-focused difficulties in emotion regulation, lack of emotion awareness and emotional clarity. ^{g*}

PA = Positive affect. NA = Negative affect. Majority of the studies did not account for the effects of all five types of CM. * Studies that account for all five types of CM. References: ^aSomers et al. (2017), ^bWarmingham et al. (2022), ^cOshri et al. (2015), ^dYoung & Widom (2014), ^eBurns et al. (2010), ^fWooten et al. (2022), ^gBerzenski (2019), ^hVolgenau et al. (2022), ⁱXiang et al. (2020), ^jGlaser et al. (2006), ^kInfurna et al. (2015), ^lTuriano et al. (2017), ⁿJennissen et al. (2016). See for comparable definitions of the types of abuse and neglect also Teicher & Samson (2013) and Bernstein et al. (2003).

function of emotions and can help to identify what is well-adjusted and dysfunctional emotional development (e.g., Cicchetti & Ng, 2014). CM effects on emotion dynamics may also help us to better understand the characteristics of healthy emotional functioning that underlie the mental and physical health and resilience that most people show against, or despite, psychopathology and major adversity (American Psychiatric Association, 2022; Bonanno et al., 2004). By doing so, we hope that this study strengthens the emerging literature on differences between CM types to bolster the promise to tailor interventions and help foster resilience and positive outcomes (see Masten et al., 2021; Orbske & Smith, 2012).

Below we first introduce the different CM types, our conceptualization of five emotion dynamics, their known connections, our model, and conclude with a synthesis and discussion of our study results.

Childhood maltreatment and developmental outcomes

The severity of commonly distinguished types of CM such as abuse (emotional, physical, sexual) versus neglect (emotional/physical) has been linked to a range of negative outcomes. In general, CM predicts both internalizing and externalizing symptoms in later life

Table 2. Overview of emotion dynamic of interest in this study and associated mental health states

Emotion dynamic	Definition and operationalization	Mental health associations in adulthood
Intensity	Baseline, average intensity average (M)	NA + with internalizing disorder D_x . ^g
Variability	Range of fluctuations standard deviation (SD) or variance	NA + with depression (D_x), ^b bipolar spectrum D_x ; ^c PA- with depression D_x , ^b with internalizing disorder D_x ; ^g and eudaimonic well-being, ^b
Instability	The square root of the mean squared successive difference (rMSSD) measures both variability (magnitude of fluctuations) and temporal dependency as average change in emotional intensity between two successive measurement occasions.	NA + and PA + associate with current anxiety D_x , ^a depression D_x , and NA + with bipolar spectrum D_x ; ^c and hypomanic personality; ^c NA- was associated with eudaimonic well-being, ^b PA/NA, and life satisfaction. ^b
Inertia	The autocorrelation quantifies emotional persistence which may capture inflexibility.	NA + and PA + associate with depression D_x , ^d and PA with hyperthymic temperament ^e , PA+ externalizing disorder D_x . ^g NA- associates with satisfaction with life, ^b PA/NA eudaimonic well-being. ^b
Emodiversity	Variety of one's emotional repertoire. Gini coefficient: the weighted sum of the frequencies of various same-valence emotions divided by the product of the total frequency of all same-valence emotions, and the total number of emotion categories.	NA+/PA + is protective against depression S_x , ^e NA + more anxiety/depression S_x . ^f

PA = Positive Affect. NA = Negative Affect. D_x = diagnosis. S_x = symptoms. ^a Schoevers et al. (2021) ^bHouben et al. (2015), ^cSperry et al. (2020), ^dKuppens et al. (2010), ^eQuoidbach et al. (2014), ^fUrban-Wojcik et al. (2022), ^gScott et al. (2020). * Hyperthymic temperament (hyperthymia) is a personality trait characterized by low-grade mania, a general and persistent positive mood, excessive optimism, and a high level of energy and activity, and reduced negative emotions such as anxiety and sadness.

(Spinoven et al., 2016; Waxman et al., 2014). Individuals who have experienced emotional neglect or abuse are at a heightened risk of developing anxiety and depression disorders (Kuzminskaite et al., 2021). Furthermore, there are also more specific processes, as emotional neglect specifically has been associated with an increased risk of developing avoidant and schizoid personality disorders (Waxman et al., 2014). Negative CM effects are often explained in terms of hypothalamic–pituitary–adrenal-axis dysregulation, leading to altered hormone secretion and cumulative wear-and-tear on the body, also referred to as allostatic load (see Kuzminskaite et al., 2021; Schenk et al., 2018; van der Kolk, 2014).

One theory holds that not all CM experiences influence the stress response system similarly, as some result in more blunted and others elicit more reactive stress responses (McLaughlin & Sheridan, 2016). This disruption of stress response systems is also evident in the specific clusters of adult physical symptoms that are associated with different types of CM (Eilers et al., 2023), as well as findings from brain functioning studies showing activation differences between CM types (Cassiers et al., 2018). This literature supports the idea that some CM experiences increase the risk of adversity more than others or tend to have different consequences. Although the optimal way to distinguish between different CM characteristics remains debated (see elaborations in McLaughlin et al., 2021; Pollak & Smith, 2021; Smith & Pollak, 2021), most academics distinguish abuse/threat from neglect/deprivation, or distinguish five CM types such as outlined above and in Table 1, as this may enrich the knowledge derived with a more crude cumulative risk approach (McLaughlin & Sheridan, 2016).

In this work, we argue that the increased risk of developing psychological problems among individuals who experienced CM might be attributable to alterations in emotional development. Part of the individual differences may still be explained by abuse versus neglect experiences, or by emotional versus physical harm. CM has been shown to affect the frequency, intensity, and variability of emotions that survivors experience, such as fewer and less intense

positive emotions, and more frequent and intense negative emotions (Infurna et al., 2015; Lavi et al., 2019; Turiano et al., 2017). Additionally, CM can influence various aspects of emotional processing, such as perception, recognition (e.g., alexithymia), understanding, expression, regulation, categorization, and the diversity of emotion concepts that individuals use (Cicchetti & Ng, 2014; Cicchetti & Toth, 2015; Gruhn & Compas, 2020; Harms et al., 2019). CM may also distort children's awareness of and sensitivity to internal bodily states – called interoception – which is essential for adaptive emotional and psychological functioning and development (Khalsa et al., 2018; Murphy et al., 2017), and therefore may be associated with adult emotional functioning.

One perspective on how CM types may differentially affect adult emotion dynamics is the theory of constructed emotion, which posits that emotions are personalized and context-dependent experiences that serve the core purpose of helping individuals navigate their environment and achieve their personal goals (Barrett, 2017). In the context of CM experiences, such personal goals (as adults) may well be connected to the past, such as an increased need for safety, physical well-being, or autonomy (Campos et al., 1994). One adaptive emotion response to CM can be understood as a “better safe than sorry” or conservative behavioral strategy (Nesse, 2019; van den Bergh et al., 2021), which is reflected in more frequent negative emotions and fewer positive emotions. This heightened frequency and intensity of negative emotions has often been compared to an alarm signal that emphasizes the importance of self-protection and safety (Rozin & Royzman, 2001; Tugade, 2010). Positive emotions, on the other hand, may serve as signals for exploration and the downregulation of sympathetic arousal. Although a more sensitive emotional alarm system may help protect the maltreated child, it may have more harmful downstream effects over adulthood (Nesse, 2019). Evidence for different associations between CM characteristics and emotion dynamics is scarce, beyond emotion valence and frequency, arguably also because it has rarely been tested.

Differential effects of childhood maltreatment

Studies have shown differential imprints of CM types on emotional development, with these effects being detectable in children as young as three months old in terms of emotion displays (Cicchetti & Ng, 2014; Cicchetti & Toth, 2015). While such differences in emotional development shall be most prominent in childhood, some CM effects may still be present in adulthood expressed as differences in emotion dynamics (Luke & Banerjee, 2013), such as more and more variable negative and fewer positive emotions. In general, emotional dysregulation is associated with physical abuse and neglect, as well as sexual abuse, but reportedly not with emotional maltreatment (Kim & Cicchetti, 2010), although they did not distinguish abuse from neglect. It is also important to consider that previous generations (e.g., born between 1900 and 1970) children were more likely to be maltreated, as rates of child maltreatment have been steadily decreasing in the past decades (e.g., Bullinger et al., 2020). However, older adults' emotional functioning also seems to be more positively tuned due to age-related factors, including reductions in experiencing negative emotions (Carstensen et al., 2011; Riediger & Rauers, 2014). These age-related effects and other factors can thus influence the observed associations between CM and emotional functioning.

Distinct forms of CM may also differentially impact patterns of (adult) socio-emotional, cognitive, and neurobiological functioning (Cassiers et al., 2018; Harms et al., 2019; McLaughlin & Sheridan, 2016; McLaughlin et al., 2014), which may subsequently alter adult emotion dynamics. Particularly, acts of threats (different forms of abuse) and acts of deprivation (different forms of neglect) are proposed to serve as two different dimensions of influence on child and adults' development, as outlined, and this idea is bolstered by evolutionary theory on conditional adaptation (Berman et al., 2022; Ellis et al., 2022; McLaughlin & Sheridan, 2016). An environment of neglect deprives a child from basic human needs, and minimal scaffolding and interactions with caregivers in such contexts may lead to a limited development of complex cognitive and emotional functioning in neglected children (Lambert et al., 2017; Machlin et al., 2019; Tottenham, 2015). Neglected children often show attenuated emotional experiences or "flat affect" and have more difficulties in recognizing emotions (see Table 1), and this may persist into adulthood.

Acts of threat such as abuse may represent profoundly different experiences than deprivation and are more likely to alter cognitive processes related to fear learning and reactivity to negative stimuli (Cicchetti & Toth, 2015; Hildyard & Wolfe, 2002). Stressful and uncertain environments tend to simplify (or focus) information processing and affect emotion functioning such that individuals become more aware of negative information at the expense of positive information (Zautra et al., 2002). This shrinks people's affective repertoire (cf. Davis et al., 2004), and as such, positive and negative emotions become more separated and negatively correlated thus becoming more independent of one another.

Although different objective and subjective features of CM may shape the functioning of emotions (see Table 1), the differential impact of commonly studied CM types (as conceptualized by Bernstein et al., 2003) on adult daily emotional functioning remains understudied. Differential associations between CM types and adult emotional functioning may also partly be a consequence of the heterogeneity in the definition of CM types across studies. Different maltreatment types also share some characteristics, and often co-occur, which may obfuscate their independent or unique associations with emotion dynamics when this is not adjusted for

(Green et al., 2010; Scott et al., 2010). Fortunately, the unique associations of specific CM types can be estimated in statistical models with mutual adjustment, which may help identify specific mechanisms (see Table 1) versus shared associations with adult emotion dynamics.

Emotion dynamics

Emotion dynamics are patterns in how individuals experience fluctuations in their emotions over time which tend to be informative on individuals' well-being and their risk of developing specific types of psychopathology (see Table 1 and Houben et al., 2015; Reitsema et al., 2022a). These emotion dynamics are often derived from intensive diary studies in which people are measured multiple times across many days (in our paper 90 assessments over 30 days, see method section). Such daily emotions can be categorized according to their valence (from positive to negative) and arousal or bodily activation (from activated to deactivated), following the structure of the affect circumplex (Russell, 1980; Yik et al., 1999), as illustrated in Figure 1. Functionally, emotion systems serve to identify and handle information that is essential to an individual's goals and well-being (Barrett, 2018; Frijda, 2007). Changes in emotions are key to their informational value because as individuals adapt over time to the situation, their attention can shift to new information (see Reitsema et al., 2023 for details). Emotion dynamics are therefore central to adaptive functioning (Kuppens & Verduyn, 2017). The five most commonly studied measures of emotion dynamics are emotion intensity, variability, instability, inertia, and emodiversity patterns (Dejonckheere et al., 2019; Houben et al., 2015; Kuppens & Verduyn, 2017), which are defined in Table 2, together with observed associations with various mental health indices.¹ These five measures of emotion dynamics cover the intensity of emotions and their fluctuations.

Through emotion socialization (e.g., Eisenberg et al., 1998), children acquire the emotional repertoire and flexibility that they need to adjust to environmental demands and achieve personal goals (Barrett, 2018; Tamir et al., 2020). CM threatens the optimal development of these processes (see Table 1). Emotions involving substantial physical activation, such as anxiety, are not only costly at the physiological level but they also reduce one's sensitivity to other environmental stimuli (Lyubomirsky, 2011). High-arousal and intense emotions should therefore be regulated down to allow the mind to shift to contextual novelty and change ("hedonic adaptation," see Reitsema et al., 2023). A reduction in NA is not necessarily mirrored by improvements in PA, as positive and negative affect can change independently of each other, depending on stress levels (i.e., affect is more bipolar during stress; Ong et al., 2006; Zautra et al., 2002, 2005). This implies that risk/protective factors can have different effects on NA compared to PA and that we should study CM-type effects on both.

Recall that with age most people tend to increase in mean intensity PA and decrease in their mean intensity NA, a negativity bias in youth that fades with age (Carstensen et al., 2011), and which is especially pronounced for activated emotions; but whether and how emotion dynamics vary with age is less clear (Reitsema et al., 2022a). Functionally, an optimal emotional response lies in the middle of a hypothetical continuum that runs from being insensitive or "rigid" (emotional inertia) to being "flexible" or "overwhelmed" (emotional instability, see Bos et al.

¹Extensive reviews of associations between emotion dynamics and mental health are given elsewhere by Houben et al. (2015), Kuppens & Verduyn (2017), and Reitsema et al. (2022a), among others.

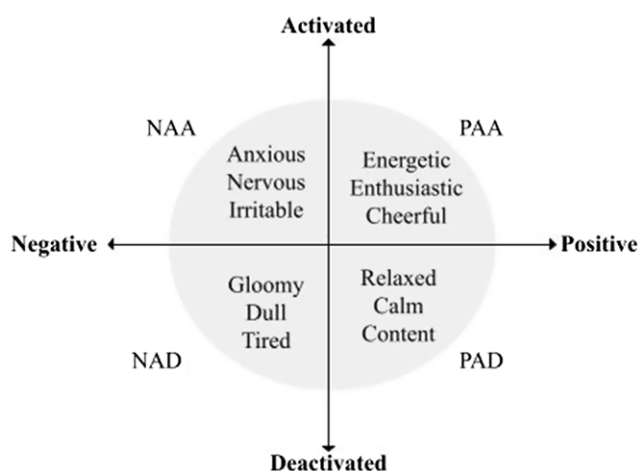


Figure 1. Circumplex model of positive and negative affect (PA/NA) adapted from Russell (1980) and Yik et al. (1999) containing the 12 emotions under study. PAA = positive affect activated; PAD = positive affect deactivated; NAA = negative affect activated; NAD = negative affect deactivated.

(2019), Bosley et al. (2019) and Reitsema et al. (2022b)). Adaptive patterns of emotion functioning have been characterized by low emotion intensity, low variability, instability, and inertia of both positive and negative affect (Ernst et al., 2020; Gruber et al., 2013; Houben et al., 2015).

Emotional inflexibility can be expressed through high inertia whereas emotional variability may capture differential sensitivity to environmental cues (see Table 2), and both low and high variability and inertia have been considered to reflect disruptive emotion fluctuations (Kuppens & Verduyn, 2015). To illustrate this, consider the example of conflicts between adolescents and their parents. The frequency of such conflicts tends to increase when adolescents exhibit either very low or high emotional variability, as demonstrated by Lichtwarck-Aschoff et al. (2009). Emotion diversity can also be informative about (mal)adaptive, flexible mental states since experiencing a wider range of emotions can signal more conceptual knowledge (Barrett, 2018), which may result in better adjustment to environmental changes.

In this paper, we zoom in on these different emotion dynamic patterns and examine whether they show distinct associations with CM types. Rather than proposing specific hypotheses about the associations between CM types and dynamic patterns, we anticipate that certain characteristics of maltreatment, such as acts of deprivation or abuse, may give rise to distinct adaptive responses and changes in emotional functioning. We expect that such changes manifest in unique patterns of emotion dynamics.

Social support

Previous work showed that social support is protective in the aftermath of CM in terms of mental and somatic health and well-being (Brewin et al., 2000; Chiang et al., 2018; Cicchetti, 2013). Accordingly, social support may help normalize maladaptive emotional functioning in CM populations which is known as the “stress-buffering” hypothesis (Cohen & Wills, 1985; Hostinar et al., 2014), and thereby affect emotion dynamic patterns.

This study

Despite a booming emotion literature, our understanding of how specific types of CM shape emotion landscapes and dynamics

remains largely uncharted territory (see overview in Table 1). The consequences of CM on emotional experiences are studied mostly through cross-sectional and experimental studies, and most previous work on emotion fluctuations pertained to emotional reactivity to stressors or positive experiences (Glaser et al., 2006; Infurna et al., 2015). The present study aimed to examine the downstream consequences of CM types on five emotion dynamic measures that play a key role in mental health and well-being in youth (Reitsema et al., 2022b) and adults (Houben et al., 2015; Kuppens & Verduyn, 2017), namely, the intensity, variability, instability, inertia, and diversity of positive and negative emotions (see Table 2). We expected that the five CM types would show unique associations with our 18 emotion dynamic estimates (see Fig. 1), namely, five emotion dynamics separately for positive and negative affect ($5 \times 2 = 10$), and emotion intensity, variability, instability, and inertia also separate for high low/high-arousal emotions ($4 \times 2 = 8$). Our measurement model was therefore statistically adjusted for all other CM types to identify each unique association with differences in adult emotional functioning. Note that by doing so, we do not focus on the CM associations with emotion dynamics that are shared between the CM types, which may have a larger effect size magnitude. We also examined whether daily social support moderated these specific CM effects on emotion dynamic indices.

Method

Participants

Data were derived from 14,418 participants of the “HowNutsAreTheDutch” crowd-sourcing study of the general population (HND, van der Krieke et al., 2016), from which 456 participants were selected, who completed both a 30-days diary study and the Childhood Trauma Questionnaire (CTQ, Thombs et al., 2009). Participants who had not completed at least 65% (58/90) of measurements ($n = 166$) were excluded from the main analyses. Other requirements for participation included being aged 18 or older, having a phone with an internet connection, and no major daily routine disruptions during the 30-days study period (e.g., shift work, planned trips). Before enrolling, participants had to approve that their anonymized data be used in scientific research. The inclusion criteria resulted in a final sample ($n = 290$, 64%) with an age range from 19 to 73 and a mean age of 41.2 years ($SD = 13.5$). In comparison with the general HND pool of participants, our sample comprised more women (83% versus 65%), more highly educated (93% versus 75%), and slightly younger participants (mean age 41 versus 45).

Procedure

The data collection for the HND research project started on December 19th, 2013 in the Netherlands, and we invited all Dutch-speaking adults in the Netherlands to participate using local and national radio, television, newspapers, magazines, and social media (see van der Krieke et al. (2016) for details). Dutch adults from the general population were invited to create an account on the online platform (<https://www.hoegekis.nl/>) and to participate in the cross-sectional and/or longitudinal study.

The cross-sectional study consists of four mandatory modules (“start,” living situation, affect/mood, and well-being) and diverse additional sections of participants’ choice (e.g., personality, somatic symptoms, or childhood adversity). Once participants completed a module instant automated feedback was received

online based on their scores, such as comparisons with the score range and average HND participant's scores. In addition, suggestions were presented to contact health services such as general practitioners or specialized organizations for additional information and assistance, as well as to preserve participant privacy. This also applied to the childhood adversity module and feedback page.

The diary data collection launched in the Netherlands on May 22nd 2014 through the same platform as an extension of the cross-sectional study that started in December 2013. In the diary study participants had to complete a block of questions regarding their mood and activities thrice per day (maximum of 90 assessments) with a six-hour interval, at a measurement schedule participants could choose at the beginning of the enrollment (e.g., starting at 9:00 am would result at 3:00 pm and 9:00 pm). After receiving a text message invitation participants had one hour to start with the completion of the diary questions. Participants were informed about the requirements and procedure of the diary study (e.g., should take place during normal life and not during hospitalization or holidays). If participants completed at least 65% of the assessments, they received automated basic personalized feedback through graphs and narratives, and those who completed more than 75% of the diary assessments received more advanced feedback with personalized longitudinal network model graphs (see van der Krieke et al., 2016, 2017). Participants did not receive financial or other rewards for their study participation, next to automated feedback and their contribution to science.

All the data we used were extracted on the 19th of December 2018. The study was approved by the Medical Ethical Committee of the University Medical Center Groningen (registration number: M13.147422 and M14.160855).

Measures

Emotion dynamics

All emotion dynamic measures were calculated per participant for 12 momentary emotion items selected from the circumplex model of affect. This model distinguishes emotions according to the valence and arousal/activation dimensions of affect (Barrett & Russell, 1998; Yik et al., 1999). Activated positive affect (PAA) was measured by feeling energetic, enthusiastic, or cheerful, and deactivated positive affect (PAD) was measured with the emotions of relaxed, calm, and content. Activated negative affect (NAA) was measured with the emotions anxious, nervous, and irritable, and deactivated negative affect (NAD) with the emotions gloomy, dull, and tired. Each item was rated on a visual analog scale ranging from *Not at all* (0) to *Very much* (100). All affect composites were calculated as the mean of the three items.

For each person, a set of summary statistics of the dynamic measures intensity (mean), variability (SD), instability (square root of the mean squared successive difference, rMSSD), and inertia (autocorrelation) were calculated separately for the four composite affect measures (PAA, PAD, NAA, and NAD), across all 90 measurement occasions. For the main analyses, the missing values were omitted, and emotion dynamic measures were therefore calculated based on only the available data. For the sensitivity analyses, missing values were imputed. The autocorrelation was defined as the correlation of the original variable (e.g., PAD) with the lagged score of the same variable (1 lag-PAD). Emodiversity scores are typically operationalized with a Gini (G) coefficient that ranges from 0 to 1 (Benson et al., 2018).² The G score was calculated based on the frequency of same-valence emotions, over

90 measurement occasions, where the intensity of the emotions was rated 10 or higher on the scale 0–100, following the example of Dejonckheere et al. (2019). The cutoff point of $\geq 10/100$ was chosen because the values 0–9 could be unintentionally marked when moving the slider down to 0 (on a 0–100 scale).

Childhood maltreatment

Childhood maltreatment was measured with a retrospective self-report Dutch version of the short form of the Childhood Trauma Questionnaire (CTQ-SF, Bernstein et al., 2003; Thombs et al., 2009). The CTQ measures types of abuse and neglect that are reflected in the WHO's (2006) definition of child maltreatment, and the CTQ is widely used in research (Viola et al., 2016). The CTQ uses 24 items to measure three types of abuse: physical (e.g., I was punished with a belt, a board, a cord, or some other hard objects), emotional (e.g., People in my family called me things like "stupid," "lazy," or "ugly"), and sexual (e.g., Someone tried to touch me in a sexual way or tried to make me touch them). Additionally, two types of neglect are distinguished: physical (e.g., I didn't have enough to eat); and emotional (e.g., My family was a source of strength and support). Items are scored on a 5-point Likert scale (1 = *never true*, 2 = *rarely true*, 3 = *sometimes true*, 4 = *often true*, 5 = *very often true*). In the Dutch version, one item for sexual abuse was omitted ("I believe I was molested") because of translational nonequivalence (Thombs et al., 2009). In our sample, the overall trauma scale showed good reliability (Cronbach's $\alpha = .91$), as did the subscales Physical Abuse (.81), Emotional Abuse (.85), Sexual Abuse (.93), and Emotional Neglect (.85). However, the reliability score for Physical Neglect was moderate (.57), which has previously been reported in community samples (Hagborg et al., 2022; Scher et al., 2001; Thombs et al., 2009).

Social contact

We calculated social contact frequency as a proportion of the time participants responded to the item "most of the time since the last measurement I was in company" (categorical) over the maximum number of measurements of a given participant, to account for missing assessments over the 90 measurements.

Statistical procedures

All the analyses were performed using R (R Core Team, 2021) and were pre-registered (osf.io/4jbcy). The distribution of childhood maltreatment was marked by high skewness and kurtosis (see Table 3; Fig. 2a). Among the emotion dynamic indices, positive emodiversity was highly kurtotic (see Supplementary Figure S1). Due to the non-normality of the data, we used Spearman correlations (Schober et al., 2018) to assess the associations between maltreatment types and CTQ score, and non-parametric tests for group comparisons using bootstrap strategies. In the calculation of emotion dynamics, we first excluded missing values, after which we repeated the analysis using an imputed dataset, to check for robustness. The final data structure did not contain missing values since emotion dynamics and social contact frequency were calculated for each participant using their available data, and all participants completed the maltreatment (CTQ) questionnaire. The variance inflation factors for each type of maltreatment ranged from 1.38 to 3.31, all far below the tolerance cutoff of five for multicollinearity (James et al., 2013).

²The values of G coefficient are on a scale 0–1 where low numbers imply high diversity. For the simplicity of interpretation we inverted it via 1-G where high coefficients would denote high emodiversity.

Table 3. Descriptive statistics

Variable	Mean	SD	Min	Max	Skew	Kurtosis
Age	41.22	13.5	19	73	0.15	−1.04
Social contact frequency	67.29	22.04	5	100	−0.61	−0.43
Emotion dynamics						
Intensity						
PAA	52.74	12.73	3.75	90.23	−0.29	1.25
PAD	59.88	12.12	3.32	95.92	−0.47	2.29
NAA	21.44	14.09	1.86	88.61	1.21	1.94
NAD	30.25	14.78	4.25	89.39	0.91	1.22
Variability						
PAA	14.6	3.98	5.73	27.15	0.33	0.09
PAD	12.95	3.53	3.02	23.88	0.36	0.23
NAA	11.43	3.97	1.91	23.28	0.14	−0.14
NAD	13.57	3.56	4.67	23.97	0.17	−0.14
Instability						
PAA	17.26	5.19	5.02	37.50	0.42	0.24
PAD	15.34	4.73	4.41	36.01	0.67	0.79
NAA	13.70	5.00	2.18	37.78	0.70	1.84
NAD	15.79	4.50	5.19	28.55	0.35	−0.31
Inertia						
PAA	0.30	0.20	−0.27	0.80	−0.23	−0.29
PAD	0.29	0.20	−0.38	0.81	−0.13	0.02
NAA	0.26	0.21	−0.27	0.78	0.12	−0.50
NAD	0.32	0.21	−0.38	0.81	−0.35	0.13
Emodiversity						
Positive affect	0.99	0.03	0.64	1	−7.79	81.48
Negative affect	0.77	0.17	0.22	1	−0.47	−0.42
Childhood maltreatment						
Total score	38.84	11.85	24	97	1.55	3.19
Physical abuse	5.81	2.14	5	21	3.84	16.77
Emotional abuse	9.11	4.02	5	24	1.41	1.78
Sexual abuse	4.93	2.49	4	20	3.45	12.79
Physical neglect	6.82	2.30	5	19	1.92	4.08
Emotional neglect	12.19	4.64	5	25	0.54	−0.03

PAA = Positive Affect Activated, PAD = Positive Affect Deactivated, NAA = Negative Affect Activated, NAD = Negative Affect Deactivated. Variables were considered to be non-normally distributed at skewness scores > 2 and kurtosis > 7 (West et al., 1995), and these estimates are depicted in bold.

To examine the associations between five types of maltreatment as predictors and 18 emotion dynamics as an outcome, we used Structural Equation Modeling (SEM) within the R-package *lavaan* (Rosseel, 2012). To account for normality violations in the data, a robust maximum likelihood estimator (MLM in *lavaan*) was used to fit our SEM models. MLM provides the Satorra-Bentler scaling correction for χ^2 , robust SE, and other corrected fit indices (Root Mean Square Error of Approximation (RMSEA) and the Bentler Comparative Fit Index (CFI)). A stepwise backward selection procedure was applied to reduce an unrestricted SEM model in which all paths between the five types of maltreatment and 18

emotion dynamics were estimated, to derive the most parsimonious Final model (see Table 4). Nested models were compared using the Satorra-Bentler corrected $\Delta\chi^2$ difference test (Satorra & Bentler, 2010) until a most restricted “Final model” was selected for which the $\Delta\chi^2$ difference test was below $p < .05$ (all model selection details are provided in Supplementary Table S1). The goodness of fit of the final model was assessed based on cutoff values of four criteria recommended by Kline (2016): χ^2 test statistics (df) and p value, RMSEA ($< .08$), Standardized Root Mean Squared Residual (SRMR $< .10$) and CFI ($> .95$). A posteriori power analysis was calculated for the final SEM model with the *SemPower* package (Jobst et al., 2021); based on the obtained sample size, df , RMSEA and alpha, a power of .93 was achieved for our SEM model. Note that the power to reliably detect each specific path in the SEM model may be lower.

To test the moderation effect of social contact frequency, first, an interaction effect for each significant variable in the model was created (as suggested by Schoemann and Jorgensen, 2021), and then added to the Final model in path analyses.

For the robustness analyses, we imputed missing values for each participant's time series with the *imputeTS* package (Moritz & Bartz-Beielstein, 2017). Moving average mean level method was used, with one window observation, meaning that mean values were computed based on one prior and posterior observation for every missing value. When two or more consecutive observations were missing, the closest previous and posterior observations were used. The Final SEM model was estimated with imputed dataset.

Effect sizes

Three effect size indices are common to express results in psychology: correlations (r), Cohen's d , and partial regression coefficients (β). We classified correlations (r) and beta's (β) as small if they were between 0.10 and 0.19, moderate between 0.20 and 0.29, and large from 0.30, based on effect sizes commonly found in social psychology (Peterson & Brown, 2005; Richard et al., 2003). We restrict our discussion to results of at least a small effect magnitude.

For an effect size of around $r = .20$ (the average effect in personality and social psychology over the past century, Richard et al., 2003), studies need at least 150 participants, and ideally up to 250 participants are needed to reduce estimation error in correlations (Schönbrodt & Perugini, 2013). Our sample of 290 seems therefore large enough for reliable estimates. Given the explorative nature and design of our study, we accentuate practical significance (effect sizes) and not statistical significance (p -values), which means we adhere to conventional p -values unadjusted for multiple testing (Cohen, 1990; Nakagawa, 2004).

Results

Sample description

In our sample, 166 participants (36%) did not complete the minimally required 58 diary assessments and were excluded from the analyses. Group comparisons showed no salient differences between the 290 included participants who completed at least 65% of the diary assessments and the 166 who did not in terms of age ($t_{(454)} = -1.22$, $p = .36$), gender ($\chi^2_{(1)} = 0.81$, $p = .37$), or education level ($\chi^2_{(7)} = 10.25$, $p = .17$), and neither in the pre-diary measure of positive affect ($t_{(443)} = -1.66$, $p = .06$), or overall maltreatment (CTQ) scores ($t_{(454)} = 1.88$, $p = .30$). Excluded participants reported slightly more pre-diary negative affect ($t_{(443)} = 1.89$, $p = .02$).

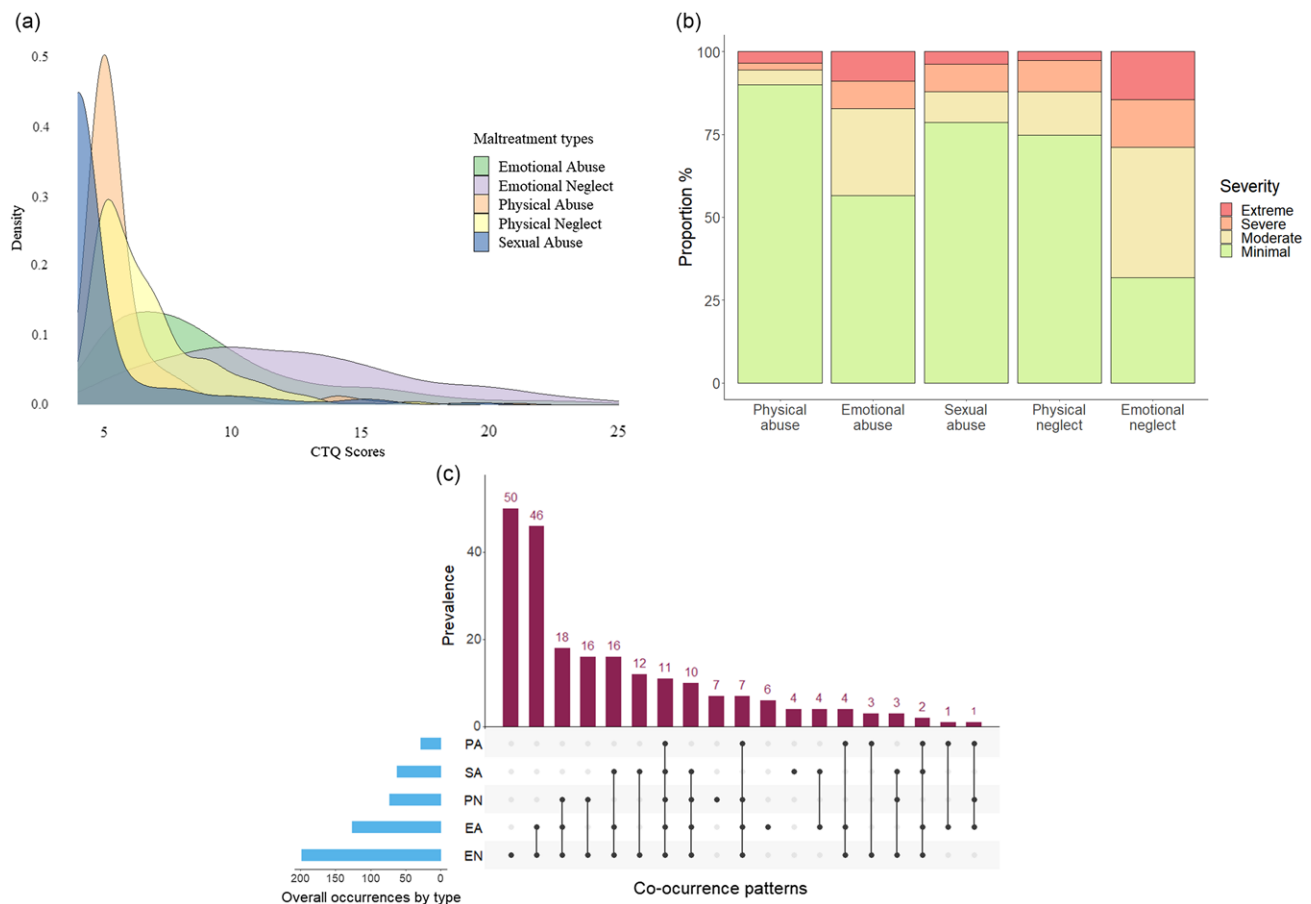


Figure 2. *a.* CTQ scores distribution across maltreatment types. CTQ = childhood trauma questionnaire. *b.* The prevalence of the five types of child abuse and neglect in our sample. *c.* The pattern of co-occurrences across maltreatment types. EA = emotional abuse; EN = emotional neglect; PA = physical abuse; PN = physical neglect; SA = sexual abuse. The vertical bars represent the number of (co)occurrences of each combination of maltreatment types. The horizontal bars represent the overall number of occurrences of maltreatment type. The occurrence of maltreatment was calculated based on cutoff values for “moderate” intensity (including “severe” and “extreme” values, e.g., 10 and higher total score for emotional neglect (Bernstein & Fink, 1997); the scores of “none to minimal” were not taken into calculations). Emotional neglect is the most common, followed by the combination of emotional abuse and neglect. The graph omits 12 logically possible combinations that were not found in our data and are not represented in the graph (i.e. null co-occurrences).

We checked for outliers (participants who never scored above 0 on any of the emotion items), but none were identified. The distribution of positive affect emodiversity indicated high kurtosis and most of the maltreatment types showed deviations from normality (see Fig. 2a and Table 3).

The bivariate correlations between maltreatment types, emotion dynamic measures, age, gender, social contact frequency, and education are presented in Table 5. Older and lower-educated participants reported more CM, especially more neglect and emotional abuse. Older adults also reported more intense positive affect and less intense negative affect, as well as more stable emotions and less diverse negative emotions (see Table 5). None of the emotion dynamic measures correlated significantly with education. Higher social contact frequency correlated with higher positive and lower negative affect and less diverse negative emotions as well as lower levels of emotional abuse and neglect.

The correlations between different CM types illustrate the common co-occurrence of different trauma types, such as physical- and emotional abuse ($r = .48$), and emotional abuse and neglect ($r = .64$). The co-occurrence of sexual abuse and physical neglect was least likely ($r = .18$). Finally, emotional abuse ($r = .82$) and neglect ($r = .90$) were the best indicators of “general CM” (total CTQ scores, see Table 5 and Fig. 2a). The unadjusted associations

between each maltreatment type and emotion dynamic are presented in Table 5.

The prevalences of specific types of abuse and neglect in our study (taking severe to moderate levels in Fig. 2b) can be put into perspective using European (EU) community averages (e.g., Gilbert et al., 2009; Sethi et al., 2013) and estimates in a landmark study in California (e.g., Dong et al., 2004), which we now present for emotional neglect (29% in our sample versus 18% in EU and 15% in California), physical neglect (12%/16%EU/10%), and emotional abuse (17%/29%EU/10%) and physical abuse (6%/23% EU/26%) and sexual abuse (12%/10%EU/21%). This suggests our sample shows comparable CM prevalences.

Childhood maltreatment and emotion dynamics

The most unrestricted model estimating all possible associations between five maltreatment types and 18 emotion dynamics comprised 64 associations (“paths”) that could be removed without worsening the model fit (see Supplementary Table S1 for step-by-step details). Fit indices of the Final model indicated a good statistical fit to the data ($\chi^2 = 41.34$, $df = 64$, $p = .99$; with CFI = 1, RMSEA = 0.00 [95% CI = 0.00, 0.00]), SRMR = 0.04). Some emotion dynamic measures (inertia and emodiversity) had

Table 4. Table present standardized (β) regression coefficients between emotion dynamics and maltreatment types

	Emotional neglect		Physical neglect		Sexual abuse		Physical abuse	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Intensity								
PAA	-.22***	(.06)						
PAD	-.31***	(.06)	.08*	(.03)				
NAA	.21***	(.05)						
NAD	.27***	(.06)						
Variability								
PAA	-.13*	(.05)						
PAD	-.12*	(.05)						
NAA	.09***	(.02)	-.15**	(.05)	.14*	(.06)		
NAD			-.15**	(.05)	.15***	(.04)		
Instability								
PAA	-.13**	(.05)						
PAD	-.13**	(.04)			.06*	(.03)		
NAA			-.12*	(.05)	.13*	(.05)		
NAD			-.15**	(.05)	.14**	(.04)		
Inertia								
PAA			-.06*	(.03)			.05*	(.02)
PAD					-.10*	(.04)		
NAA	.16**	(.05)					-.05	(.03)
Emodiversity								
Positive affect	-.18**	(.06)						
Negative affect	.18**	(.06)						

PAA = Positive Affect Activated. PAD = Positive Affect Deactivated. NAA = Negative Affect Activated. NAD = Negative Affect Deactivated. Note that positive affect emodiversity and inertia PAA/NAD were unrelated and therefore not part of the Final model. Significant at * $p < .05$, ** $p < .01$, *** $p < .001$.

low variances (e.g., 0.03), which could potentially have hampered the estimation of associations between specific maltreatment types and these variables.

The path coefficients of all significant associations are presented in Table 4. In the Final model, four types of abuse uniquely predicted 17 emotion dynamic measures with little overlap in pattern of emotional experiences. Emotional abuse was not independently associated with any of the emotion dynamic measures. Below, we describe how the remaining four types of maltreatment differentially associate with the five studied emotion dynamic indices.

Emotional neglect showed to be the most influential type of maltreatment, displaying associations with all five emotion dynamic indices with the highest coefficients (e.g., PAD $\beta = .31$). In addition, of all types of maltreatment, mostly emotional neglect was associated with positive emotion dynamics (lower intensity, variability, instability of PAA/PAD and emodiversity of positive affect). Although sexual and physical abuse and neglect showed associations with some indices of positive emotion dynamic, because of very small effect size (see method sections) these results will not be discussed. Lastly, emotional neglect was associated with some indices of negative affect (with mean intensity NAA/NAD, inertia NAA and negative affect emodiversity). Childhood physical neglect and sexual abuse both predicted negative affect variability (NAA/NAD) and instability (NAA/NAD) but in the opposite direction (sexual abuse increasing and physical neglect decreasing trends).

Moderation effect of social contact frequency

A moderation effect of social contact frequency was added for each path in the final model. We found a significant moderation effect only for the associations between sexual abuse and inertia and instability of PAD, but the strengths of these associations were rather small ($\beta = -.05$ and $.09$ respectively).

Sensitivity analyses

The final SEM model was fit to the imputed dataset, as outlined in the statistical procedure section. The model fit indices showed equally good statistical fit to the data than for our unimputed model ($\chi^2 = 47.92$, $df = 64$, $p = .93$; with CFI = 1, RMSEA = 0.00 [95% CI = 0.00, 0.01]), SRMR = 0.04). The standardized β coefficients changed slightly for some paths. The most prominent changes were observed in the associations between physical abuse and emotion dynamics measures, which disappeared, while associations between sexual abuse and instability of NAD as well as emotional neglect and variability of NAA reached significance at $p < .001$. All model path coefficients are provided in Supplement Table S3.

Post hoc analyses

Because of the high correlations between most of the emotion dynamic measures and age, we examined whether age moderated

Table 5. Spearman correlation between model variables

	Age	Gen	SC	PA	EA	SA	PN	EN	Total CTQ
Age			.03	.12	.20	.13	.22	.23	.25
Gender ^a	.27		-.11	.07	-.04	-.08	.11	.11	.07
Education ^b	-.18	-.10	.04	-.12	-.10	-.12	-.20	-.11	-.15
Intensity									
PAA	.13	.09	.20	-.06	-.17	-.05	-.14	-.22	-.20
PAD	.08	.11	.22	-.03	-.18	-.03	-.13	-.27	-.23
NAA	-.24	-.10	-.16	.05	.22	.02	.15	.22	.23
NAD	-.18	-.14	-.17	.09	.25	.11	.19	.26	.28
Variability									
PAA	-.23	-.19	-.01	.05	.00	-.07	-.07	-.08	-.05
PAD	-.17	-.11	.03	.03	.03	-.02	-.03	-.06	-.03
NAA	-.30	-.21	-.06	.08	.15	.09	-.01	.13	.15
NAD	-.22	-.22	-.07	.06	.08	.11	-.10	-.01	.03
Instability									
PAA	-.21	-.15	-.04	.03	-.01	-.07	-.03	-.10	-.07
PAD	-.15	-.11	-.01	.04	.02	.01	-.02	-.07	-.02
NAA	-.29	-.22	-.08	.09	.14	.05	.02	.06	.12
NAD	-.23	-.21	-.04	.06	.08	.08	-.08	-.04	.02
Inertia									
PAA	.05	-.04	.03	.04	.01	-.01	-.08	.03	.05
PAD	.05	-.01	.12	-.08	-.04	-.07	-.05	-.02	-.04
NAA	-.01	-.02	.03	-.06	.02	.03	.04	.13	.09
NAD	.09	.01	-.04	-.05	-.04	.00	-.05	.01	.05
Emodiversity									
Positive affect	.09	.11	.08	-.09	-.14	-.02	-.03	-.10	-.11
Negative affect	-.18	-.05	-.14	.03	.19	.01	.15	.21	.23
PA			-.09		.48	.23	.26	.38	.52
EA			-.12			.28	.49	.64	.84
SA			.05				.18	.26	.42
PN			-.03					.56	.68
EN			-.14						.90

N = 290. Correlations $\geq .12$ significant at $p < .05$, $\geq .15$ at $p < .01$, and $\geq .22$ at $p < .001$. All significant correlations are shown in bold. SC = Social Contact frequency. PA = Physical Abuse. EA = Emotional Abuse. SA = Sexual Abuse. PN = Physical Neglect. EN = Emotional Neglect. PAA = Positive Affect Activated. PAD = Positive Affect Deactivated. NAA = Negative Affect Activated. NAD = Negative Affect Deactivated^a Gender coded as 0 = woman, 1 = man, which means negative values for the man group. ^b Educational level ranged from 1 (elementary school not finished) to 8 (academic degree).

the effect of CM on emotion dynamics in the Final model. None of the moderation effects were significant.

Discussion

We explored emotion dynamics after childhood maltreatment (CM) because we expected that specific characteristics of child maltreatment could affect the intensity and fluctuation patterns of adult emotions in unique ways. To this end, we examined five CM types and their differential associations with 18 adult emotion dynamic patterns over 30 days. We also assessed whether daily social contact moderated these associations. Our

results showed that CM types indeed showed unique associations with each of the measured emotion dynamics (i.e., intensity, variability, instability, inertia, and emodiversity). Emotional neglect was associated with most of the dynamic measures and predominantly with dynamics of positive emotions. Second, our results showed a distinction between abuse and neglect (acts of threat and deprivation, respectively), in how they were associated with variability and instability of affect. Third, social contact frequency did not moderate the relationship between CM and emotion dynamics. These three key observations are discussed in detail below.

Child maltreatment subtypes and emotion dynamics

Emotional neglect

Emotional neglect was associated with the greatest variety of emotion dynamic measures, namely less extreme dynamics of positive emotions (intensity, variability, instability, and emodiversity) but more extreme dynamics of negative emotions (intensity, inertia, and diversity). Overall, emotional neglect was associated with more dynamic measures of positive than negative emotions. For emotional intensity, the effect size seemed slightly larger for deactivated emotions compared to activated/aroused emotions (note beta-coefficients did not differ statistically – see supplement S3); however, the effects were more homogeneous across arousal levels for emotional variability, instability, and emodiversity.

Only emotional neglect was associated with emotional intensity in our model, specifically, lower mean levels of positive affect and higher levels of negative affect (note that we did not interpret associations between physical neglect and intensity because of their small effect sizes, see Method section). We feel this finding highlights the prominent role of emotional neglect in shaping emotion dynamics, in line with recent studies that controlled for other types of CM, although these studies did not specifically examine negative affect (but well-being, see Volgenau et al., 2022). Previous studies did report associations between emotional intensity and other types of maltreatment, specifically between emotional abuse and lower mean levels of positive affect and higher levels of negative affect (see Table 1). However, these associations were always found in models that did not account for all types of CM, including emotional neglect (Turiano et al., 2017). Our work underscores the importance of simultaneously considering different types of maltreatment when evaluating its consequences, to prevent building a body of knowledge with misleading and contradictory data.

Previous research has shown that neglected children report the lowest levels of positive affect and the highest levels of negative affect among different types of maltreatment (Hildyard & Wolfe, 2002), which we here further support in a time-series analysis. Neglected children often lack the support and scaffolding that fosters the development of socio-emotional understanding that is required for the formation and maintenance of healthy relationships (Hildyard & Wolfe, 2002; Tottenham, 2015). Emotional neglect may hinder one's ability to have positive experiences via feelings of worth, self-esteem, and trust, and lack of skills necessary to form and maintain healthy relationships (Hildyard & Wolfe, 2002; Rowell & Neal-Barnett, 2021). Additionally, (emotional) neglect may lead to a hypo-responsive reward system (Mehta et al., 2010), resulting in reduced context sensitivity as reflected in fewer, low-intensity, and less variable positive emotional experiences. Clinical levels of depression have also been associated with lower positive affect variability (Houben et al., 2015), and the inability to experience pleasure (anhedonia) is not only a key symptom of depression but is also connected to emotional maltreatment (Cohen et al., 2019).

Emotional neglect was not only associated with less extreme dynamics of positive emotions, but also with more extreme negative emotion dynamics, specifically elevated intensity, stronger persistence (inertia), and a wider variety and abundance of negative emotions (emodiversity). Negative emotions are often associated with lower well-being and form the core of many psychological disorders (Stanton & Watson, 2014). The persistence of negative emotions (inertia) may indicate reduced responsiveness to environmental cues, in line with a hypoactive reward

system. These rigid and maladaptive emotional states are typically associated with lower well-being and an increased risk of psychopathology (Houben et al., 2015; Kuppens et al., 2010). Furthermore, greater diversity in negative emotions has been associated with conditions like depression and anxiety (Urban-Wojcik et al., 2022; Werner-Seidler et al., 2020). The heightened levels, persistence, and diversity of negative emotions may also result from underdeveloped coping strategies, such as the absence of seeking support to regulate intense negative emotions, and is a hallmark of the neuroticism factor (Larsen et al., 2020). This coping deficit has been observed in adults with a history of emotional neglect, indicating its potential long-term impact (Mills et al., 2015).

Combined, low sensitivity to positive emotions and intense, rigid, and abundant negative emotions can have a detrimental effect on emotional and psychological functioning, given that emotional forms of maltreatment are the strongest predictor of adult psychopathology (Mandelli et al., 2015; Simon et al., 2009; Spinhoven et al., 2016). Moreover, reduced experiences of positive affect, crucial for resilience and adaptation to stress, can further impede individuals with a history of emotional neglect in coping with daily stress (Tugade, 2010). Given that emotional neglect was the most prevalent among all types of maltreatment in our study (see Figure 2B/C, but also MacDonald et al., 2016), and is strongly associated with adult mental health and well-being (Bullinger et al., 2020; Sethi et al., 2013), it becomes imperative to study the underlying mechanisms behind these consequences and find ways to mitigate their effects; to stop the “neglect of neglect” (Hildyard & Wolfe, 2002).

Physical abuse

Physical abuse is one of the most salient and openly aggressive forms of maltreatment, with numerous sequelae in childhood and/or adolescence (Petersen et al., 2014; Krugman & Korbin, 2022), although the evidence for a negative impact on mental health over adulthood remains inconclusive (Carr et al., 2013; Kong et al., 2018; Spinhoven et al., 2010, 2016; Volgenau et al., 2022). Previous studies did not always account for other types of maltreatment when assessing the consequences of physical abuse, although in those studies that did, physical abuse was no longer associated with emotional (dys)regulation (Burns et al., 2010; Oshri et al., 2015). Arguably other forms of maltreatment are more harmful than physical abuse due to the relative visibility of physical abuse, which might more often result in help or support.

An alternative explanation for the lack of (unique) associations between physical abuse and emotion dynamics is that most of the individuals in our sample reported low levels of physical abuse severity, and if they reported physical abuse, this always co-occurred with another type of abuse and neglect (see Fig. 2b, c and results), resulting in a sample suboptimal (i.e., unable) to detect specific physical abuse effects on emotion dynamics. Note that we studied associations between physical abuse and adult emotion dynamics that were *unique* to physical abuse (versus other CM types), which does not negate adverse effects of physical abuse that are *shared* with these other CM types (also see Table 5).

Previous work has reported poor emotion regulation in children exposed to physical abuse, resulting in more aggressive and disruptive behavior (Teisl & Cicchetti, 2008), which could also result in altered emotion dynamics. Future work could therefore focus on evaluating the consequences of physical abuse on adult functioning in more detail, such as dissecting differences in

physical abuse frequency and severity, especially in adult general population samples, and ideally in a longitudinal or lifespan study.

Another possibility could be that physical abuse could have the weakest effect of the five CM types on emotional functioning in the long term. Previously, we argued that once children become adults, and feel that they no longer can be physically hurt, they may feel that their future is unlikely to be as bad as their past has been (a sense of control), which may result in fast recovery (resilience) or even show some positive growth. Some previous research is in line with this idea, as physical abuse has been found to be associated with an array of positive adult outcomes, such as higher positive affect, lower depressive and anxiety symptoms, more happiness, self-acceptance, personal autonomy, higher control and coping, among others (Jeronimus et al., 2023; Sudbrack et al., 2015).

Emotional abuse

Emotional abuse was not uniquely associated with any emotion dynamic indices and therefore removed from our model (in Table 4). Previous studies reported associations between emotional abuse and emotional dysfunction (see Table 1); however, few studies adjusted for all five types of maltreatment. Due to the high co-occurrence between emotional abuse and neglect in our sample (Fig. 2c), our model could have failed in differentiating emotional abuse and neglect in terms of how they associate with specific emotional dynamic processes. Although a vast body of research shows that emotional maltreatment is associated with negative outcomes, emotional neglect often receives less attention in comparison to emotional abuse. Moreover, studies often either omit emotional neglect or combine neglect with abuse and hence do not disentangle the adverse effects of emotional abuse from those of emotional neglect (Gardner et al., 2019; McKay et al., 2022).

There is evidence to believe that emotional neglect has a broader and more persistent influence on adult emotion functioning than emotional abuse because neglect affects more domains of emotional functioning (see Clarke, 2015; Egeland et al., 1983; Hildyard & Wolfe, 2002), including emotion regulation and attachment, and emotional clarity (while emotional abuse does not, see Jessar et al., 2017), whereas abuse seems to have a more targeted influence on self-esteem or confidence. Similarly, in the context of emotional disorders, some studies reported that only emotional neglect remains a significant predictor of disorder after emotional abuse is accounted for (see Hovens et al., 2015). Emotional neglect may also result in a (more) toxic rearing environment that reduces survivors' ability to cope with subsequent abuse and stress (Hildyard & Wolfe, 2002; Teicher & Samson, 2013), and by doing so, moderate the impact of abuse on emotional dynamic outcomes.

The question of whether emotional abuse contributes to downstream consequences above effects shared with emotional neglect remains a venue for further research. Studies with more homogenous prevalences of each type of emotional maltreatment may reveal more insight into emotional processes as possible consequences of emotional abuse and neglect.

Sexual abuse

Sexual abuse was primarily associated with negative affect dynamics, namely, higher variability and instability of both high and low arousal (NAA/NAD), although the effect sizes were slightly larger for the low arousal spectrum. High variability and instability, regardless of valence, is a reflection of low well-being and is shared by many psychological disorders (Houben et al., 2015). Studies on emotional functioning have associated sexual

abuse with high impulsivity (Oshri et al., 2015), which can reflect an inability to downregulate negative emotions (Houben et al., 2015). Indeed, sexual abuse has previously been associated with more negative emotions such as anxiety, depression, shame, guilt, anger, and fear (Kendall-Tackett et al., 1993), which we now showed using dynamic measures. Our results are in line with the view that childhood abuse can lead to a cognitive and emotional processing style adapted for the detection of negative events (see the Neglect vs Abuse section). Higher sexual abuse was also associated with lower PAD inertia, although its effect size was somehow smaller than for negative effect. This study shows that the unique effects of sexual abuse on adult emotion dynamics (adjusted for other CM types) pertain to more fluctuations in negative emotions.

Physical neglect

Physical neglect was associated with variability and instability of high and low arousal of negative affect (NAA/NAD), similar to sexual abuse, but there was a major difference: unlike sexual abuse, physical neglect was associated with reduced fluctuations in negative emotions. These findings highlight that there seem to be differences in the consequences of a child being exposed to acts of threat versus deprivation. Lower emotion variability and instability, in general, have been associated with higher levels of well-being, and especially low negative affect instability with higher eudaimonic well-being (Houben et al., 2015), which, paradoxically, suggests better adaptation in adults with a history of physical neglect. Very low emotion fluctuation could also reflect contextual insensitivity, which is maladaptive in adulthood (Kuppens & Verduyn, 2015). These findings highlight our rudimentary understanding of what makes emotion functioning (mal)adaptive and stresses the need to study how emotion regulation repertoires can be contextually (mal)adaptive, as processes that may have been protective in the abusive childhood, can become a source of adult psychopathology.

Neglect versus abuse

Our final model showed some differences between the effects of abuse and neglect on emotion dynamics fluctuations. Although abuse was associated with higher variability and instability of negative emotions (NAA/NAD), the opposite pattern was true for neglect (i.e., lower variability, and instability).

Researchers have suggested that deprivation (neglect) and threat (abuse) have distinct consequences on children's cognitive and emotional development (Lambert et al., 2017; Machlin et al., 2019; McLaughlin & Sheridan, 2016; McLaughlin et al., 2014), especially via learning processes, when abuse may sensitize cognitive and emotional processes involved in fear learning and reactivity to negative stimuli, which would be adaptive in stressful environments. This could result in heightened variability and instability of negative emotions as observed in our study. This is also in line with studies showing a link between abuse and impulse control difficulties (Oshri et al., 2015). On the other hand, neglected children might be deprived of sufficient opportunities to develop adaptive emotional functioning, which could lead to reduced sensitivity to emotional stimuli, thereby reducing the variability and instability of negative and positive emotions.

Our study results also align with the associations between neglect and attenuated emotional experiences in children (Cicchetti & Toth, 2015) and lower emotional knowledge and understanding (Hildyard & Wolfe, 2002; Shipman et al., 2005). Scaffolding and interactions with caregivers are necessary to

develop a refined emotional understanding and regulation skills (see introduction). Specifically, neglect was found to be associated with difficulties in recognizing (positive) facial expressions (Doretto & Scivoletto, 2018; Young & Widom, 2014), and reduced sensitivity to affective words (Warmingham et al., 2022), emotional awareness, clarity, and discrimination (Berzenski, 2019; Hildyard & Wolfe, 2002; Jessar et al., 2017), although not in all studies (see Wooten et al., 2022). This literature suggests that neglected individuals shall tend to experience a lower variety and abundance of emotions. Although we did find an association between emotional neglect and lower positive emotion diversity, the opposite pattern emerged for negative emotion diversity, which suggests more variation in their use of negative emotions.

One could speculate that neglect should “flatten” emotion dynamics (e.g., lower variability or “blunted affect”), as one has learned to become emotionally unresponsive to specific contextual information, and endures/ignores the associated and familiar negative emotions, as this has been observed for children after their needs were consistently disregarded, ignored, invalidated, or unappreciated, after which the child went into “I’m on my own” modus and became emotionally disconnected (see Ludwig & Rostain, 2009). This is a common intergenerational loop (e.g., Greene et al., 2020; Osborne et al., 2021), and flattened affect has even been reported in the context of overabundant wealth, when the family does not meet a child’s emotional or safety needs (Ludwig & Rostain, 2009).

The reviewed literature in this paper and our results support a growing understanding that abuse and neglect may elicit different sequelae, including how emotions are experienced, recognized, and regulated. We think that our work bolsters the idea of the multidimensionality of CM experiences in line with current debates in the literature (e.g., work by McLaughlin et al., 2014, 2016), showing that threatening and deprived environments often shape emotional development in divergent directions. CM types typically co-occur in individuals (Fig. 2c), but still, about 16% of participants (1:6) reported only emotional neglect, which allowed us to examine unique effects, which may help us to better understand CM consequences. We acknowledge that progress in the study of maltreatment types and their different consequences also requires stronger theories and instruments (Pollak & Smith, 2021; Smith & Pollak, 2021) but our models on unique CM-type effects on emotion dynamics support the idea that maltreatment characteristics have to be studied beyond the common subdivision of abuse versus neglect.

Emotion dynamics

Previous studies have suggested that adaptive emotional functioning can be characterized by less variable, less unstable, and less inert emotion dynamics (Gruber et al., 2013; Houben et al., 2015). Such a profile might be found in individuals who are moderately emotionally reactive to events and skilled in downregulating their (intense) negative emotions, which results in fluctuations with less extreme peaks that quickly return to their baseline levels. However, the characteristics of our study and sample preclude broadly generalizable statements about what constitutes adaptive emotional functioning. Patterns of emotional fluctuations in CM survivors can be argued to represent an adaptive pattern in part reflecting the environment in which these individuals grew up. Adults who reported being exposed to threatening environments as a child (in the case of abuse) showed an emotion dynamic pattern characterized by heightened sensitivity to negative emotional events, resulting in higher ups and downs of negative

emotions in their daily lives. In contrast, individuals who reported they had been deprived of parental care and socialization showed an opposite pattern with lower responsiveness to events (both negative and positive), resulting in less fluctuating negative and positive emotions.

Early CM experiences may also shape the child’s environment over time in such a way that patterns of emotional functioning reinforce themselves. For example, children exposed to abuse may show an attentional vigilance and adaptation to threats that paradoxically increases the likelihood that they will experience threats in the future, and reduces the likelihood of protective experiences and developing and sustaining supportive relationships (Hildyard & Wolfe, 2002; McCrory & Viding, 2015). Experiencing fewer positive emotions may further increase these children’s experiences of stress, as positive emotions play a central role in the prevention of adverse physiological effects of stress (Folkman & Moskowitz, 2000; Tugade, 2010), and the positive effects of social relationships.

Social contact frequency

In our study, the frequency of social contact did not influence much of the associations between CM types and emotion dynamics with the exception of sexual abuse which is associated with the instability and inertia of unaroused positive affect. The small effect sizes in our complex model kept us from a more detailed discussion of these results. It is mostly established knowledge that social support is beneficial for psychological adjustment across a wide range of stressful situations (Taylor, 2011), including mitigation of negative effects in CM experiences (Chiang et al., 2018; Cicchetti, 2013; Eilers et al., 2023). A possible explanation for our results can be found in how social support is measured, such as by social contact frequency, which disregards more subjective perceptions of whether these contacts were supportive (or intimate or meaningful) or not, but is most frequently used in research, and also by us. Data on the number and characteristics of the daily social company of participants or family systems perspectives could have provided a more fruitful contribution to the literature on the role of social support after CM (e.g., Wiehe, 1998).

Strengths and limitations

This paper examined differences in adult emotion dynamics associated with specific CM types, which is new to the literature. The unique associations between specific types of childhood abuse and neglect and adult dynamic indices can offer a window of opportunity to deepen our knowledge on (mal)adaptive emotion functioning and the common co-occurrence of CM (Vachon et al., 2015). The unique or incremental effects of each maltreatment type on the emotion dynamic indicators were dissected statistically by adjusting for their shared variance. Previous research suggested that emotion dynamics beyond the mean and SD of positive and negative affect may not be informative on differences in psychological functioning and well-being (Dejonckheere et al., 2019), but in our study, we found several unique associations between CM types and specific dynamic patterns. This underscores the value of considering multiple emotion dynamic patterns simultaneously. In addition, this is one of the few studies on emotions that categorized affect scores not only by valence (positive/negative) but also along the arousal dimension (low to high), following the emotion circumplex, which helped identify some small but informative outcome differences.

One limitation of our study is that we used broad composite affect scales (PAA/PAD/NAA/NAD), which can obscure the existence of different patterns of dynamics of the single emotions that these scales contain (see Ernst et al., 2020; Reitsema et al., 2022a). Another limitation of this work is that the resilience capacity of CM survivors was not taken into account (Cicchetti, 2013), which potentially generates “noise” in our attempt to isolate the true and unique adverse consequences of specific CM types (Nishimi et al., 2020). For instance, Warmingham et al. (2022) identified six clusters or emotion regulation profiles among emerging adults with CM histories, and two profiles associated with healthy emotional functioning (e.g., characterized by high positive effect and adaptive regulation strategies), and were present in 27% of the sample. Future studies should not ignore the effect of resilience, especially in general population samples.

Another limitation is that we restricted ourselves to linear measures of emotion dynamics, and between CM types and dynamic measures, whereas a broad range of options on nonlinear emotion dynamics could offer a broader view on emotion functioning (Kunnen et al., 2019). Additionally, autocorrelation calculations (emotional inertia) are influenced by the spacing between experience sampling assessments; shorter time intervals yield higher autocorrelations. Given that emotions differ in their duration (Verduyn et al., 2009), we may have failed to capture the lingering effects of some emotions. Finally, the calculation of the emotion dynamic pattern emodiversity suffers from some statistical limitations (Brown & Coyne, 2017). Due to the way emodiversity is calculated, the range of possible emodiversity scores is small, which likely reduced the variance in our sample, and possibly the power to detect associations with CM in our study. Moreover, the most accurate way to measure the variety of individuals’ emotion experiences would be to use an open-ended response format instead of a researcher-determined list of emotion items, although this is more difficult in experience sampling studies, and possibly more burdensome for participants.

The present study is also limited by retrospective bias when measuring CM, particularly in the design, as participants themselves decided to take CTQ survey (see Baldwin et al., 2019). Although in some contexts retrospective measures of maltreatment might seem as an inferior measure in comparison to prospective reports, we believe that there is merit also in using retrospective measures in CM studies. It has been argued that only subjective perceptions of CM relate to downstream negative consequences, as the risk of psychopathology is minimal or the same as in individuals who did not report CM, despite being identified as victims of CM in legal cases (Danese & Widom, 2020, 2023). Perhaps it is partly the impact of CM on identity and social network formation and the expectation of heightened risk of adverse outcomes that propels aversive outcomes (Danese & Widom, 2020), which could in theory even arise from a failure to thrive (Kempe et al., 1962). There may also be merit in asking adults retrospectively, as the review by Baldwin et al. (2019) showed that ~56% of adults who retrospectively reported childhood maltreatment had no concordant prospective measures (e.g., via court case, parent, or teacher report).

In addition, although the Childhood Trauma Questionnaire stands as one of the most firmly established tools for retrospectively assessing child maltreatment (next to interviews, see Saini et al., 2019), research has found that some of the five assessed factors exhibit problems with internal consistency (Georgieva et al., 2021). Particularly the subscale physical neglect has shown poor internal consistency compared to the other subscales. Future

research should therefore focus on improvement of the items and the subscale of physical neglect in particular. Robust subscales are essential when one aims to categorize and compare maltreatment types as we did. Also, the larger subjectivity of emotional neglect reports and the fact that both measures of neglect (CTQ) and emotion diary items used affect terms could have resulted in shared method variance, which artificially strengthens the link between emotional neglect and current positive and negative effect.

The generalizability of our study findings is limited by our participants being Dutch (a Western, educated, and rich country), and our heterogeneous sample had a wide age range. Emotion dynamics might change with age, as patterns tend to stabilize in older adults (see introduction), which was not accounted for in our analysis. Note, however, that age was not observed to moderate effects of CM types on emotion dynamics in our study. Furthermore, we only analyzed data from individuals who freely chose to answer childhood maltreatment questions (probably omitting the “silent” group), and who were persistent enough in the diary study part (e.g., completed 65% of measurements, see method section). These participants were also more highly educated and more often women compared to the Dutch population (see Methods section, and for elaborate comparisons of scores on a range of measures in this diary sample versus Dutch population samples, see van der Krieke et al., 2016, 2017).

Finally, a SEM with many variables, such as our unrestricted baseline model, would also benefit from a bigger sample size, however, intensive time series are costly, and our focus on the population of CM survivors reduces the number of eligible participants. Based on our power calculations and model strategy we deem our results reliable, but models are a simplification of reality at best, and we undoubtedly missed the weaker associations that one might also observe in much larger samples, and associations that we could not observe due to our sample characteristics, including how participants experienced their childhood, such as the absence of participants in our study who only reported physical abuse. How our study results generalize to other populations remains unknown until estimates of unique effects of CM types on emotion dynamic indices become available from multiple studies with diverse instruments, sampling rates, and participants, including clinical and prisoner samples, which tend to report higher CM exposure. CM-type prevalences in our sample were broadly in line with those in the general populations in Europe and California.

Conclusion

Most studies on childhood maltreatment and emotions focused on emotion dysregulation and maladaptive coping strategies and differences in emotional processing and used a cumulative maltreatment scale. In the present study, we expanded this knowledge base (see Table 2) and identified how five specific types of child abuse and neglect are associated with differences in adult emotion functioning using the five most popular dynamic indices. We observed that emotional abuse stood out because no unique association with any of the studied emotion dynamics was observed. Emotional neglect, in contrast, showed most unique associations with emotion dynamics, especially with reduced positive affect and more fixed emotion patterns, whereas physical neglect was uniquely associated with reduced negative affect fluctuations. Sexual abuse is associated with more variable negative affect. This study shows that different CM types had their specific associations with a range of adult emotion dynamics, setting the

groundwork for further research into how CM types and emotion dynamics shape adult health and well-being.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/S0954579423001530>.

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Author contribution. SM and BJ conceived the analyses strategy. SM and AM operationalized the emotion dynamics. SM analyzed the data. PJ and BJ organized the HowNutsAreTheDutch crowd-sourcing study and acquired funding and provided the data. All authors made significant contributions to the content of the paper and interpretations of the results.

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