

*Adults with a history of childhood maltreatment with and without mental disorders show alterations in the recognition of facial expressions*

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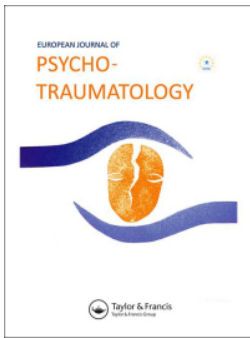
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## Adults with a history of childhood maltreatment with and without mental disorders show alterations in the recognition of facial expressions

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### ABSTRACT

**Background:** Individuals with child maltreatment (CM) experiences show alterations in emotion recognition (ER). However, previous research has mainly focused on populations with specific mental disorders, which makes it unclear whether alterations in the recognition of facial expressions are related to CM, to the presence of mental disorders or to the combination of CM and mental disorders, and on ER of emotional, rather than neutral facial expressions. Moreover, commonly, recognition of static stimulus material was researched.

**Objective:** We assessed recognition of dynamic (closer to real life) negative, positive and neutral facial expressions in individuals characterised by CM, rather than a specific mental disorder. Moreover, we assessed whether they show a negativity bias for neutral facial expressions and whether the presence of one or more mental disorders affects recognition.

**Methods:** Ninety-eight adults with CM experiences (CM+) and 60 non-maltreated (CM-) adult controls watched 200 non-manipulated coloured video sequences, showing 20 neutral and 180 emotional facial expressions, and indicated whether they interpreted each expression as neutral or as one of eight emotions.

**Results:** The CM+ showed significantly lower scores in the recognition of positive, negative and neutral facial expressions than the CM- group ( $p < .050$ ). Furthermore, the CM+ group showed a negativity bias for neutral facial expressions ( $p < .001$ ). When accounting for mental disorders, significant effects stayed consistent, except for the recognition of positive facial expressions: individuals from the CM+ group with but not without mental disorder scored lower than controls without mental disorder.

**Conclusions:** CM might have long-lasting influences on the ER abilities of those affected. Future research should explore possible effects of ER alterations on everyday life, including implications of the negativity bias for neutral facial expressions on emotional wellbeing and relationship satisfaction, providing a basis for interventions that improve social functioning.

### Adultos con antecedentes de maltrato infantil con y sin trastornos mentales muestran alteraciones en el reconocimiento de las expresiones faciales

**Antecedentes:** Las personas con experiencias de maltrato infantil (MI) muestran alteraciones en el reconocimiento de emociones (RE). Sin embargo, investigaciones previas se han centrado principalmente en poblaciones con trastornos mentales específicos, lo que no deja claro si las alteraciones en el reconocimiento de las expresiones faciales están relacionadas con el MI, con la presencia de trastornos mentales o con la combinación de MI y trastornos mentales, y en el reconocimiento de expresiones emocionales, en lugar de expresiones faciales neutras. Además, comúnmente, se investigó el reconocimiento de material de estímulo estático.

**Objetivo:** Evaluamos el reconocimiento de expresiones faciales negativas, positivas y neutras dinámicas (más cercanas a la vida real) en individuos caracterizados por MI, en lugar de un trastorno mental específico. Además, evaluamos si muestran un sesgo de negatividad por las expresiones faciales neutras y si la presencia de uno o más trastornos mentales afecta el reconocimiento.

**Métodos:** 98 adultos con experiencias MI (MI+) y 60 controles adultos no maltratados (MI-) vieron 200 secuencias de video en color no manipuladas, que mostraban 20 expresiones faciales neutras y 180 emocionales, e indicaron si interpretaban cada expresión como neutral o como una de las ocho emociones.

**Resultados:** El MI+ mostró puntuaciones significativamente más bajas en el reconocimiento de expresiones faciales positivas, negativas y neutras que el grupo MI- ( $p < .050$ ). Además, el grupo MI+ mostró un sesgo de negatividad para las expresiones faciales neutras ( $p < .001$ ). Cuando se tomaron en cuenta los trastornos mentales, los efectos significativos se

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### KEYWORDS

Facial emotion recognition; child maltreatment; negativity bias; neutral expressions; mental disorders

### PALABRAS CLAVE

Reconocimiento facial de emociones; maltrato infantil; sesgo de negatividad; expresiones neutras; trastornos mentales

### 关键词

面部情绪识别, 儿童虐待, 消极偏差, 中性表情, 精神障碍

### HIGHLIGHTS

- Child maltreatment (CM) in adults is linked to emotion recognition alterations if no current mental disorders are present.
- Interpretation of positive, negative and neutral facial expressions is impaired.
- Adults with a history of CM tend to interpret neutral expressions as negative.

mantuvieron constantes, excepto por el reconocimiento de expresiones faciales positivas: los individuos del grupo con MI+ pero sin trastorno mental puntuaron más bajo que los controles sin trastorno mental.

**Conclusiones:** El MI podría tener influencias duraderas en las habilidades de RE de los afectados. Futuras investigaciones deberían explorar los posibles efectos de las alteraciones del RE en la vida cotidiana, incluidas las implicaciones del sesgo de negatividad para las expresiones faciales neutrales en el bienestar emocional y la satisfacción con las relaciones, proporcionando una base para las intervenciones que mejoran el funcionamiento social.

### 具有童年期虐待史的有、无精神障碍的成年人在面部表情识别上表现不同

**背景:** 有童年期虐待 (CM) 经历的个体表现出情绪识别 (ER) 的改变。然而, 以往研究主要关注患有特定精神障碍的人群, 这使得面部表情识别的改变是否与 CM、精神障碍的存在或 CM 与精神障碍的结合, 以及对情绪性而非中性的面部表情的 ER 相关尚不清楚。此外, 通常还研究了静态刺激材料的识别。

**目的:** 我们评估了有 CM 特征而不是特定精神障碍的个体对动态 (更接近现实生活) 消极、积极和中性面部表情的识别。此外, 我们评估了他们是否对中性面部表情表现出消极偏差, 以及一种或多种精神障碍的存在是否会影响识别。

**方法:** 98 名有 CM 经历的成年人 (CM+) 和 60 名未受虐待的成年人 (CM-) 观看了 200 段未经处理的彩色视频序列, 显示了 20 种中性面部表情和 180 种情绪性面部表情, 并指出他们是否将每种表情解释为中性或作为八种情绪之一。

**结果:** CM+ 在识别积极、消极和中性面部表情方面的得分显著低于 CM- 组 ( $p < .050$ )。此外, CM+ 组对中性面部表情表现出消极偏差 ( $p < .001$ )。当考虑精神障碍时, 除了对积极面部表情的识别, 显著效应保持一致: 来自 CM+ 组但并非没有精神障碍的个体得分低于没有精神障碍的对照组。

**结论:** CM 可能对受影响者的 ER 能力产生长期影响。未来的研究应该探索 ER 改变对日常生活的可能影响, 包括中性面部表情的消极偏差对情绪健康和关系满意度的影响, 为改善社会功能的干预措施提供基础。

## 1. Introduction

Child maltreatment (CM) is common, affecting 16–23% of the global population (Sethi et al., 2013). It is defined as (sexual, physical or emotional) abuse and/or (physical or emotional) neglect of children that occurs within a relationship of responsibility, trust or power (World Health Organisation, 2020). Next to a strong link between CM and impaired physical health (Bellis et al., 2015; Huffhines & Jackson, 2019; Hughes et al., 2017), individuals who experienced CM are vulnerable to develop mental disorders in adulthood (Brietzke et al., 2012; Cicchetti & Toth, 2005). Many adults with schizophrenia (56.1%), bipolar disorder (56.3%), persistent depressive disorder (75.4%), and major depressive disorder (57.1%) report having experienced CM (Struck et al., 2020). Additionally, adults with CM experiences have a significantly greater likelihood of being diagnosed with personality disorders, mood disorders, and post-traumatic stress disorder (PTSD) (for review see Leeb et al., 2011). Moreover, they suffer from long-term effects of CM on social functioning such as low relationship satisfaction, higher rates of separation, problematic parenting behaviours, intimate partner aggression and violence (Labella et al., 2018; Savage et al., 2019; White & Widom, 2003; Zamir, 2022), reduced perceptions of social support and increased perceptions of loneliness and social isolation (Shevlin et al., 2015). To date, there is limited knowledge

on the processes that underlie these long-term social impairments. Given that positive social relationships can protect from the development of trauma-related (Wang et al., 2021) and other mental and physical disorders (Brietzke et al., 2012; Cicchetti & Toth, 2005; Holz et al., 2020; Labella et al., 2018; Leeb et al., 2011; Leigh-Hunt et al., 2017; Savage et al., 2019; Shevlin et al., 2015; Struck et al., 2020; Wang et al., 2021; White & Widom, 2003; Yule et al., 2019; Zamir, 2022), it is important to identify the processes that might contribute to broader social impairments, which will increase the capacity to intervene therapeutically (Pfaltz et al., 2022). One area that might contribute to these deficiencies is impaired learning of emotion processing such as recognition, communication, interpretation, and regulation of emotions (Young & Widom, 2014).

Although the number of studies that have assessed effects of CM on ER in adults is scarce, there has been some evidence of long-term ER alterations. Catalan et al. (2020) found that adults with a history of CM attribute expressions of anger and fear more frequently to neutral and happy faces. Likewise, Pfaltz et al. (2019), who examined adults with PTSD, discovered that individuals with high compared to low levels of CM were particularly prone to misinterpret neutral expressions as negative (i.e. anger, contempt, and sadness). Similarly, in their recent systematic review, Berube et al. (2023) reported that CM is related to an increased recognition of negative emotions like fear and anger, while the recognition of happy facial

expressions is impaired. In sum, there is evidence that in adults, CM is linked to ER alterations as well as to a tendency to interpret facial expressions as negative (negativity bias).

As populations with CM experiences are characterised by high rates of mental disorders (Brietzke et al., 2012; Cicchetti & Toth, 2005; Struck et al., 2020), research on ER has focused on individuals with CM suffering from a specific mental disorder and found alterations in ER within this population. Berube et al. (2023) reported that 33% of the studies included in their review examined the combined effect of CM and mental illness, 21% excluded participants with current or past mental illness and 46% did not report information about participants' mental health altogether. In addition, previous studies have rarely focused on the recognition of neutral facial expressions. In the review by Berube et al. (2023), only two out of 11 studies that included neutral facial expressions used an ER task, rather than an attention, matching, or gender identification task. In one of the two studies, participants were mothers with vs. mothers without CM without current mental disorders and psychopharmacological treatment (Neukel et al., 2019). The other of the two studies examined patients with depression and healthy controls with vs. without a history of CM (Suzuki et al., 2015). Hence, findings from previous studies may not generalise to the population of individuals with a history of CM and it is unclear whether alterations in the recognition of facial expressions are related to CM, to the presence of mental disorders or to the combination of CM and mental disorders (Berube et al., 2023). Moreover, the correct interpretation of neutral facial expressions is crucial as in our everyday lives, facial expressions might often be neutral (Somerville & Whalen, 2006). Thus, further studies are needed that examine possible alterations in the interpretation of neutral facial expressions in a population that is representative for individuals with CM experiences, rather than recruiting individuals with a specific mental disorder who, in addition, report a history of CM.

Finally, previous studies commonly used static stimuli (e.g. still pictures), presented with high intensity to assess ER, making it difficult to generalise results to real-life situations, where emotions are displayed dynamically. In the review by Berube et al. (2023), only one of 24 studies included videos instead of still pictures. Five of the studies transformed the pictures to provide participants with a gradual display of emotions. Yet, in real life, emotions are commonly more subtle (Bänziger et al., 2012; Wingenbach et al., 2016). Thus, a replication of previous findings with ecologically more valid stimuli is needed to better understand ER in individuals with CM.

The present study hence pursued three goals. First, to recruit a sample of adults with a history of CM

(CM+) and compare it to a sample of adults without a history of CM (CM-), rather than recruiting participants with a specific mental disorder, with and without a history of CM. Second, to assess the ability to recognise neutral (next to negative and positive) facial expressions. Third, to employ dynamic stimuli that are as close to real life situations as possible. We hypothesised that the CM+ group would achieve lower recognition rates for positive and neutral expressions, and higher recognition rates for negative expressions than unexposed individuals. Further, we hypothesised that the CM+ group would show a greater negativity bias (tendency to label neutral facial expressions as negative) than unexposed individuals. Finally, we explored whether the hypothesised group differences would remain significant when accounting for the presence of mental disorders.

## 2. Method

### 2.1. Participants

Participants were recruited from a study pool, by means of online advertising, and in collaboration with out-patient clinics in the area of Zurich. The study was approved by the local ethics committee (Kantonale Ethikkommission Zürich). All participants provided written informed consent. Inclusion criteria were: (1) age between 18 and 65 years, (2) normal eyesight (or corrected). Exclusion criteria were: (1) insufficient knowledge of German language, (2) substance abuse (current or during the last 12 months), (3) acute suicidality (assessed during screening visit), (4) psychotic symptoms (current or past), (5) current intake of medication with a potential influence on psychophysiological measurements (e.g. beta blocker) recorded in a separate study that was part of an overarching project, (6) severe medical conditions affecting psychophysiological measurements of the separate study, (7) pregnancy, (8) placement in children's home or similar institution for at least 1 year during the first 18 years of age (exclusion criterion for the separate study).

Eleven out of 109 potential participants in the CM+ group and two out of 62 potential participants in the CM- group were excluded as they met one of the exclusion criteria. This resulted in 98 (78 female) participants in the CM+ group, and 60 (45 female) participants in the CM- group. Table 1 illustrates the participants' characteristics.

### 2.2. Psychological assessment

CM was measured using the *German version of the Childhood Trauma Questionnaire-Short Form (CTQ-SF; Bernstein et al., 2003)*, in German translation and validation of (Bader et al., 2009; Karos et al.,

**Table 1.** Sample characteristics.

	CM+ (n = 98)		CM- (n = 60)		Group comparisons
	n	(%)	n	(%)	
Female gender	78	79.59	45	75.00	ns
Depressive disorder	14	14.29	0	.00	CM+ > CM-; $\chi^2 = \text{Inf}^b$
Anxiety disorders	39	39.80	10	16.67	CM+ > CM-; $\chi^2 = 10.77^b$
Obsessive-compulsive disorder	4	4.08	2	3.33	ns
Post-traumatic stress disorder	8	8.16	0	.00	CM+ > CM-; OR = $\text{Inf}^c$
Eating disorders	8	8.16	0	.00	CM+ > CM-; OR = $\text{Inf}^c$
Personality disorders <sup>d</sup>	43	43.88	3	5.00	CM+ > CM-; $\chi^2 = 29.51^a$
	<b>M</b>	<b>SD</b>	<b>M</b>	<b>SD</b>	
Age (years)	27.71	9.93	24.65	5.74	ns
Educational group	2.31	.63	2.32	.50	ns
BDI <sup>e</sup>	10.35	10.10	3.78	3.33	CM+ > CM-; $U = 4061.0^a$
CTQ <sup>f</sup> physical neglect	9.14	3.46	5.22	.52	CM+ > CM-; $U = 5244.5^a$
CTQ emotional neglect	16.14	4.98	6.83	1.40	CM+ > CM-; $U = 5643.0^a$
CTQ physical abuse	9.12	5.45	5.05	.22	CM+ > CM-; $U = 4518.0^a$
CTQ emotional abuse	13.28	6.43	5.52	.87	CM+ > CM-; $U = 5251.5^a$
CTQ sexual abuse	9.18	6.79	5.00	.00	CM+ > CM-; $U = 4110.0^a$
PDS <sup>g</sup>	1.47	1.39	.97	1.06	CM+ > CM-; $U = 3509.0^c$

Note: For count data comparison chi-square test and Fisher's exact test were used. Educational groups consisted of 4 levels: 1 = 11 years of education, 2 = 14–15 years of education, 3 = 19–22 years of education and 4 = 24–26 years of education. All *p*-values were computed two-sided. ns: non-significant, CM+: child maltreatment group, CM-: non child maltreatment group <sup>a</sup> $p < .001$ , <sup>b</sup> $p < .01$ , <sup>c</sup> $p < .05$ , <sup>d</sup>avoidant, dependent, obsessive-compulsive, paranoid, schizoid, schizotypal, histrionic, narcissistic, antisocial, borderline, depressive, negativistic personality disorder, <sup>e</sup>Beck Depression Inventory, <sup>f</sup>Childhood Trauma Questionnaire, <sup>g</sup>Post-Traumatic Stress Diagnostic Scale.

2014). The CTQ is widely used (by 67% of the studies in the review by Berube et al. (2023)). Internal consistency for the subscores is high ( $\alpha > .81$ ), except for the physical neglect subscale ( $\alpha = .49$ ). Participants with a CTQ rating higher than 'none / minimal' in at least one of the subscales according to Bernstein and Fink (1998) (i.e.  $\geq 10$  for emotional neglect,  $\geq 8$  for physical neglect,  $\geq 9$  for emotional abuse,  $\geq 8$  for physical abuse and  $\geq 6$  for sexual abuse) were included in the CM+ group. The CM- group comprised individuals with 'none / minimal' CTQ ratings on all subscales.

To characterise the sample, we assessed (1) Depressive symptoms, using the German version of the *Beck Depression Inventory* (BDI; Hautzinger et al., 1994, in German translation of Beck & Steer, 1996). The BDI comprises 21 self-report items, assessing the severity of depressive symptoms over the past week. The BDI has good validity and reliability (Hautzinger et al., 1994). (2) The number of experienced trauma types using the trauma checklist of the *Post-Traumatic Diagnostic Scale* for DSM-5 (PDS-5; Foa et al., 2016, non-published adapted German version by Elbert et al., University of Konstanz). The PDS-5 demonstrates excellent internal consistency and test-retest reliability, and good convergent validity with the PTSD Checklist – Specific Version and the PTSD Symptom Scale – Interview Version for DSM-5 (Foa et al., 2016). (3) Current mental disorders (anxiety disorders, obsessive-compulsive disorders, PTSD, eating disorders), using a semi-structured German diagnostic interview for mental disorders (*Diagnostisches Interview bei Psychischen Störungen for DSM-5* (DIPS), (Margraf et al., 2017), showing good reliability (In-Albon et al., 2008). (4) Personality disorders, using the German version of the *Structured Clinical Interview for DSM-IV*, axis II (personality disorders)

(*SKID-4*; Wittchen et al., 1997), showing adequate interrater and internal consistency reliability (Maffei et al., 1997).

Additionally, we evaluated participants' educational levels: 1 = up to 13 years of education (mandatory school years), 2 = up to 18 years of education (high school degree), 3 = up to 23 years of education (university degree; Bachelor or higher) and 4 = more than 23 years of education (university degree; PhD or higher).

### 2.3. Facial ER paradigm

We used the Amsterdam Dynamic Facial Expression Set – Bath Intensity Variations (ADFES-BIV) as stimuli, which was adapted from the ADFES (Van Der Schalk et al., 2011) and subsequently validated in a sample of 92 healthy participants (Wingenbach et al., 2016). The ADFES-BIV comprises 360 non-manipulated, coloured video sequences of facial expressions by 12 Northern European encoders (7 male, 5 female) and 10 practice videos by 10 Mediterranean encoders (5 male, 5 female); each 1040 ms in duration. This relatively short time period corresponds to everyday situations, in which individuals are usually confronted with short emotional expressions.

We used 200 stimuli from the ADFES-BIV (10 encoders (5 female, 5 male) x 9 emotions (anger, sadness, embarrassment, contempt, fear, disgust, joy, surprise, pride) and 20 neutral facial expressions) and presented them in the SR Research Experiment Builder software. Each video displayed the face of an encoder that changed from a neutral expression into one of the eight emotional expressions or remained neutral. Next, a list of the nine emotional expressions

and neutral appeared and the participants were asked to indicate with a mouse click which expression had been presented (emotion labelling).

#### 2.4. Procedure

The study was part of a larger project that investigated physical and socio-emotional consequences of CM. Study procedures comprised three laboratory appointments. At visit 1, participants signed written informed consent and graduate psychology students, trained and supervised by an experienced licensed psychotherapist (last author), assigned the questionnaires and conducted clinical interviews (CTQ-SF, BDI, PDS-5, DIPS, SKID-4). At visit 2, participants completed the above described ER paradigm (Wingenbach et al., 2016), as well as an emotion induction paradigm and a personal space paradigm. At visit 3, participants' responses to intimacy were assessed (Weilenmann et al., 2022). Participants were reimbursed with 20 Swiss Francs per hour.

#### 2.5. Statistical analyses

The analysis of the emotion surprise of the ER paradigm was left out, as surprise cannot clearly be assigned to the positive or negative category. Furthermore, for all statistical analyses, the two emotion intensity levels (1 and 3) were taken together as for the separate intensity levels, there was not enough stimulus material and therefore, the dispersion of the data were too large. The remaining emotional expressions were divided into three categories (dependent variables): positive (joy, pride), negative (anger, fear, sadness, disgust, contempt, and embarrassment), and neutral. Group differences in ER of correctly identified positive, negative, and neutral emotional expressions were calculated using R version 4.2.1 (2022-06-23). First, three variables were calculated: percentage of correctly identified positive expressions, percentage of correctly identified negative, and percentage of correctly identified neutral expressions. If a participant identified a positive emotion as another positive emotion (or a negative emotion as another negative emotion), this was counted as 'false'. Data of the positive condition was well modelled by a normal distribution according to Shapiro-Wilk's normality test ( $W = .983$ ,  $p = .053$ ). Data of the negative ( $W = .981$ ,  $p = .026$ ), and of the neutral condition were not well modelled ( $W = .868$ ,  $p < .001$ ) by a normal distribution. The Levene's test for homogeneity of variance suggested homogeneity in the variables of all three conditions ( $p > .471$ ) and no outliers were detected by box-whisker-plots. To assess whether the two study groups differ in the number of correct responses (correctly identified stimuli – e.g. anger identified as anger), Mann-Whitney-U tests were

calculated for positive, negative, and neutral emotion trials separately. Additionally, to test the influence of current mental disorder (according to the SKID-4 and the DIPS), separate t-tests for mean percentage rates of positive trials and Mann-Whitney-U tests for neutral and negative trials were conducted for comparison of the CM– and the CM+ group. Groups were compared three ways: participants of CM+ and CM– without one or more current mental disorder ( $n = 48$ ,  $n = 49$ ), participants of the CM+ group without current mental disorder with participants of the CM+ group with current mental disorder ( $n = 45$ ), and the CM+ with current mental disorder with the CM– group comprising of participants without current mental disorder. Two separate generalised linear mixed effect models (GLMM) by maximum likelihood (Laplace approximation) with binomial response variables, using the R package lme4 (version 1.1-30; Bates et al., 2015) were conducted to (1) analyse if specifically neutral facial expressions were more often interpreted as negative (dependent variable; overall counts of falsely negative identified neutral expressions) by the CM+ group, and (2) to identify if there is a potential general negativity bias of the CM+ group present (dependent variables; overall counts of falsely negatively identified neutral expressions, falsely negatively identified positive expressions, and falsely neutrally identified positive expressions) rather than the specifically expected negative interpretation of neutral facial expressions. The factor mental disorder was additionally added to the two GLMMs to check if it had an influence on the possible group effects on ER skills. One advantage of GLMMs is that they take fixed as well as random effects into account. We accounted for the both within-person and across-person source of variability, as variance due to repeated measurements within one person is smaller than between persons (correlated residuals). With a GLMM, we can consider the variance of each participant as an extra predictor and thus control for it (James et al., 2013). Hence, this variance of the correlated errors can be incorporated as a random effect to the linear predictor into the model (Johnson et al., 2015).

Supplementary, an overall summary of the ER rates by emotion and group measured with the ADFES-BIV was calculated.

### 3. Results

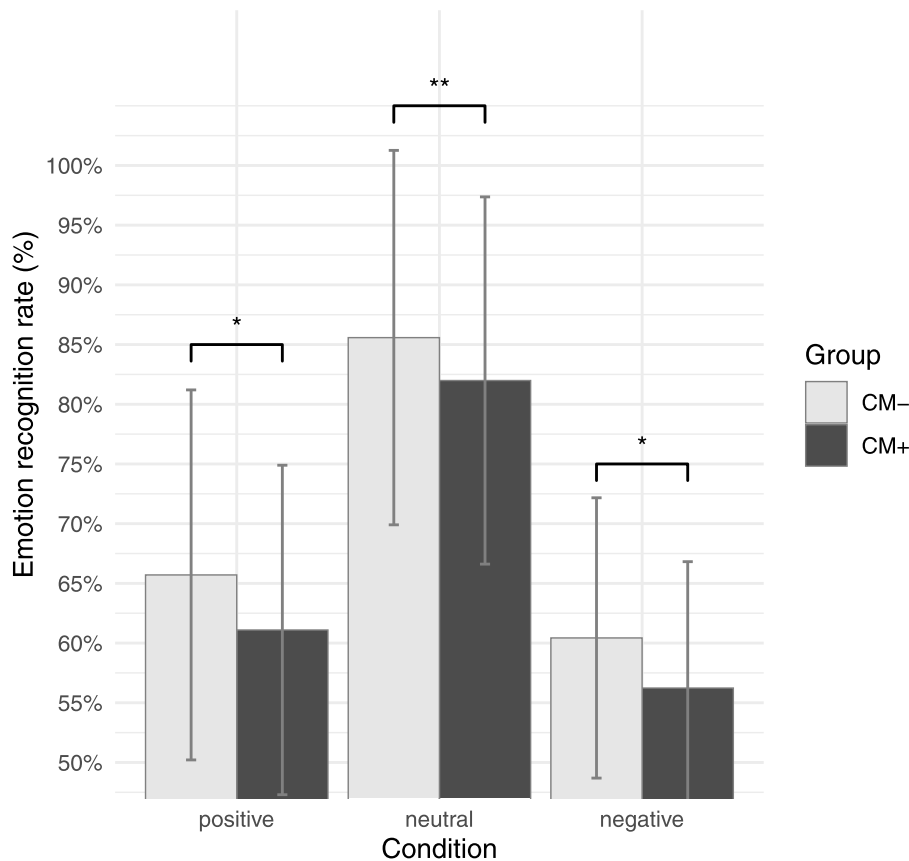
#### 3.1. Recognition rates by group

Group differences are illustrated in Figure 1, as summary statistics of ER percentage rates by group for each condition (positive, negative, and neutral).

Participants of the CM+ achieved generally lower ER rates than participants of the CM– group.



### Barplots for emotion recognition rate (%) by condition and group



Note: \*  $p < .05$  (one-tailed), \*\*  $p < .01$  (one-tailed)

**Figure 1.** Barplots for emotion recognition rate (%) by condition and group.

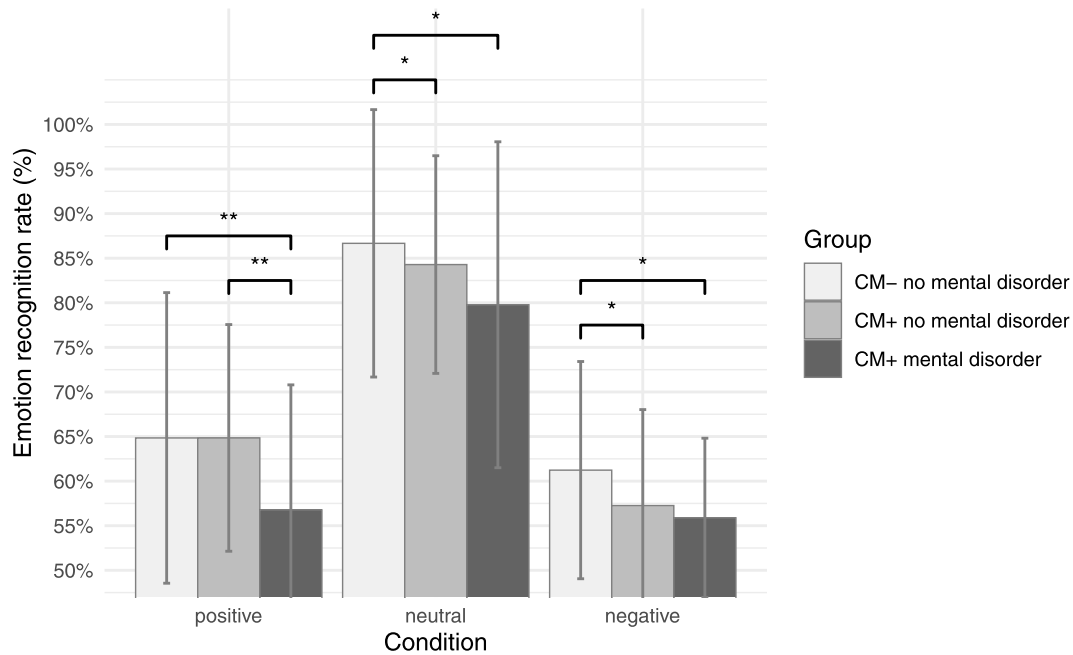
Mann-Whitney-U tests revealed significant group differences in the recognition of positive ( $U = 2368.5$  ( $p_{\text{one-tail}} = .020$ )), negative ( $U = 2250.50$  ( $p_{\text{one-tail}} = .007$ )), and neutral ( $U = 2410.00$  ( $p_{\text{one-tail}} = .027$ )) facial expressions. Significant differences in the recognition of negative and neutral facial expressions persisted when comparing the CM+ without mental disorder with the CM- group without mental disorder ( $U = 1444$ ,  $p = .027$  for negative;  $U = 1428$ ,  $p = .033$  for neutral). Participants of the CM+ with mental disorder did not show significantly different scores than participants from the CM+ group without mental disorder (negative expressions:  $U = 1174$ ,  $p = .295$ ; neutral expressions:  $U = 1197.5$ ,  $p = .235$ ) but they did show significantly different scores than the CM- group without mental disorders (negative expressions:  $U = 1434$ ,  $p = .003$ ; neutral expressions:  $U = 1313$ ,  $p = .035$ ). For the recognition of positive facial expressions, only participants from the CM+ with ( $t[90.35] = 2.56$ ,  $p = .006$ ) but not participants from the CM+ group without mental disorders ( $t[88.83] = \pm .01$ ,  $p = .504$ ) showed lower scores than participants from the CM- group without mental disorders. Participants from the CM+ with mental disorders showed lower scores than participants from the CM+ group without mental disorders ( $t[89.01] = 2.92$ ,  $p = .002$ ).

Group differences are illustrated in Figure 2, as summary statistics of ER mean percentage rates by group and mental disorder for each condition (positive, negative, and neutral). Results did not change when ( $n = 24$ ) images with low recognition rates ( $< 33\%$ ) were excluded from the analyses ( $p$ 's  $< .029$  for significant results,  $p$ 's  $> .206$  for non-significant results).

### 3.2. Negativity bias by group

The GLMM with the negativity shift defined as 'subject answered negative instead of neutral' revealed a significant group difference ( $OR = .75$ ,  $p < .001$  with a  $CI = .7450-.7466$ ). The CM+ group interpreted neutral facial expressions significantly more often as negative as the CM- group. Adding the factor mental disorders to the model had a significant effect on the negativity shift ( $OR = 1.05$ ,  $p < .001$  with a  $CI = 1.05-1.05$ ), with the group effect (CM+/CM-) remaining significant ( $OR = .79$ ,  $p < .001$  with a  $CI = .79-.79$ ). Individuals out of the CM+ group with current mental disorder had a stronger negativity bias than those without current mental disorder. The GLMM to identify a general negativity bias revealed no significant group differences ( $OR = .87$ ,  $p = .217$  with a  $CI = .69-1.09$ ). The factor mental disorders did not have a

Barplots of differences in mean of emotion recognition rate (%) by condition for CM+ and CM– with and without mental disorder



Note: \*  $p < .05$  (one-tailed), \*\*  $p < .01$  (one-tailed)

**Figure 2.** Barplots of differences in mean of emotion recognition rate (%) by condition for CM+ and CM– with and without mental disorder.

significant effect on the general negativity bias ( $OR = .68$ ,  $p = .136$  with a  $CI = .40-1.13$ ). Participants of the CM+ group with current mental disorder did not show a stronger general negativity bias than participants of the CM+ group without current mental disorder.

Age did neither correlate with ER rates, nor with the negativity bias. The overall summary statistics of the recognition rates of each emotion are illustrated in the Appendix. The maximum possible score for each emotion was 20, equalling 100%, while the minimum score for each emotion was 0, equalling 0%. While contempt was most frequently interpreted incorrectly, neutral expressions had the highest recognition rate by both groups.

#### 4. Discussion

This study investigated if adults with a history of CM show alterations in facial ER, using a dynamic stimulus set that is close to real-life conditions and if they tend to interpret neutral facial expressions as negative. As hypothesised, the CM+ group showed lower recognition rates for positive and neutral facial expressions than the CM– group. Unexpectedly, the CM+ group also scored lower in recognising negative emotions, pointing to global (non-valence specific) alterations in facial ER. In line with the hypothesis, CM was furthermore associated with negative interpretations of neutral facial expressions. When considering only

participants with CM without current mental disorder, effects remained significant for negative and neutral but not for positive expressions.

#### 4.1. ER alterations

General ER deficits have been identified in several prior studies assessing *children* exposed to CM (da Silva Ferreira et al., 2014; Luke & Banerjee, 2013). However, our finding of global ER alterations in *adults* exposed to CM is somewhat surprising. In contrast to studies with children, previous studies with adult populations mainly pointed to increased recognition rates for negative emotions (Berube et al., 2023). Contradictory findings might be explained by differences in study samples and in the applied ER paradigms. English et al. (2018) for example found that CM was related to increased recognition of fear. Their research was conducted with female undergraduate students ( $M = 18.98$  years) with exposure to emotional maltreatment. This finding might therefore not translate to a more representative CM population, including male and older individuals or individuals with other types of CM experiences, which frequently co-occur (Herrenkohl & Herrenkohl, 2009). Gibb et al. (2009) found an attention and interpretation bias for angry faces in young adults ( $M = 19.24$  years) with a history of childhood abuse. However, the authors did not assess the influence of neglect, and used photographs rather than dynamic ER stimuli. The dynamic

stimulus set used in the current study might be more sensitive in detecting ER alterations than a static stimulus set, given that emotions displayed with high intensity are less difficult to identify (Krumhuber et al., 2021). Hence, previous studies with static intense stimuli may not have captured the full range of alterations.

Importantly, significant group differences for the recognition of neutral and negative facial expressions detected in the current study persisted when accounting for mental disorder. This finding might emphasise that CM specifically affects the recognition of neutral and negative but not of positive facial expressions, for which the difference between the CM– and the CM+ group was no longer significant when assessing only participants without mental disorder.

#### 4.2. Negativity bias

We found no general negativity shift in the interpretation of facial expressions but rather, and in line with findings by Pfaltz et al. (2019) and Catalan et al. (2020), the negativity bias was confined to neutral facial expressions. That is, a specific negativity bias for neutral facial expressions was found, rather than a general negativity shift. Even though the negativity bias for neutral facial expressions was strongest in the CM+ group with current mental disorder, the group effect stayed significant. That is, both, individuals with CM experiences with and without mental disorder, showed a negativity bias for neutral facial expressions. As neutral expressions may precede, accompany, or follow sexual or physical abuse by the perpetrating caregivers (Schlumpf et al., 2013), neutral expressions might not be considered trustworthy by individuals with CM experiences. Negative schemas might influence the perception and interpretation of facial expressions. Schemas are belief patterns, developed in early childhood through past behaviours and experiences, which are thought to correspond to unmet needs in childhood relationships with significant others (Phillips et al., 2019; Pilkington et al., 2021). In fact, schemas in adulthood are associated with a history of abuse and neglect during childhood and adolescence (Pilkington et al., 2021). Moreover, in individuals with experiences of emotional and/or physical neglect, non-emotional facial expressions may represent a caregiver's lack of responsiveness and thus be perceived as aversive. While such learning processes might be adaptive in the original, maltreating environment of a child, they might contribute to interpersonal problems when persisting into adulthood and exert negative effects on social interactions and relationships. In fact, a high percentage of our sample suffered from personality disorders, which are characterised by interpersonal difficulties.

Thus, future research should investigate if alterations in the recognition of facial expressions are related to difficulties in affected individuals' everyday lives and whether they are connected to decreased relationship satisfaction and a lack of perceived social support. Ultimately, the development of interventions improving the recognition of facial expressions might provide a basis for improving relationship satisfaction and psychological wellbeing.

#### 4.3. Limitations and conclusions

A first limitation is that in our ER paradigm, which is in line with most paradigms (Berube et al., 2023), more negative (anger, sadness, fear, disgust, contempt, embarrassment) than positive (happiness, pride) emotions were presented. Thus, neutral expressions had a higher chance to be confused with negative compared to positive expressions. Given the significant group difference in the percentage of negatively (mis)identified neutral expressions, our results nonetheless speak for a negativity bias in CM+ compared to CM–. Still, future research studies should assess whether the observed negativity bias for neutral expressions can be replicated when presenting the same number of positive and negative expressions. Furthermore, the retrospective self-report assessment of CM by adults using the CTQ is a limitation, as it has been shown that prospective and retrospective measures of CM identify different groups of individuals (Baldwin et al., 2019). The CTQ is also a rather sensitive measure. In particular, the emotional neglect and sexual abuse subscales have cut-off scores that can easily be reached. In some instances, participants were assigned to the CM+ group if they reported experiences such as their parents' separation which had created a non-loving or non-caring family atmosphere during a particular time of their lives, or isolated events that were not experienced as stressful (e.g. being exposed to an exhibitionist that was unknown to them). In other words, a few participants ended up in the CM+ group that reported experiences which may not constitute CM. Furthermore, the exclusion criteria (certain medications, individuals who were removed from their homes because of maltreatment) might affect the generalizability of our results. Nevertheless, the sample of the current study reported levels (severity) of CM that are comparable to previous studies (e.g. English et al., 2018; Fani et al., 2011; Gibb et al., 2009). Another limitation is the size of the subgroups in our sample (e.g. larger subgroups with anxiety/personality disorders), which makes it difficult to ascribe our results to a general effect of mental disorder, or rather a specific mental disorder as for example anxiety disorder. Larger samples and subgroups are needed to investigate this further. Moreover, some authors (Ruba & Pollak, 2020) have recently challenged the

meaning of ‘emotion recognition’ and favour the term ‘emotion reasoning’ instead, which encompasses the ability of children to use expressive behaviours, contextual information, and their own learning histories to make reasonable and adaptive inferences and predictions about other people’s internal states and future behaviours. Future research should take this new definition into consideration and assess socio-emotional skills and their interplay more broadly. Finally, we cannot conclusively say if participants misclassified negative emotions to neutral expressions or if this is rather an artifact of general ‘non-emotional’ classification processes, since we – like most other ER studies researching individuals with CM experiences (e.g. Catalan et al., 2020; Cheng & Langevin, 2022; Pfaltz et al., 2019) did not include a geometric control condition. Future studies should thus include such a control condition as is common in MRI studies researching consequences of CM experiences (e.g. Dannlowski et al., 2012; Jedd et al., 2015; Redlich et al., 2018).

Our study using a dynamic stimulus set of emotions extends previous findings on a negativity bias towards neutral facial expressions (Catalan et al., 2020; Pfaltz et al., 2019), which does not seem to be restricted to PTSD or other mental illnesses in individuals with a history of CM. Together with broader problems in the recognition of negative and positive expressions, this might result in interpersonal problems and consolidate unfavourable past emotional experiences and corresponding schemas (Pilkington et al., 2021). Hopefully future research will contribute to better understand social problems in individuals affected by CM, and to develop effective interventions that improve social functioning.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

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### Data availability statement

The data that support the findings of this study are available on request from the corresponding author, [MCP]. The data are not publicly available due to information that could compromise the privacy of research participants.

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## Appendix

### Percentage (*M*, *SD*, *Median*, *Min*, *Max*) ER rates by emotion and group

ER rates	<i>N</i>	<i>M</i>	<i>SD</i>	Median	Min	Max
<b>happiness</b>						
CM–	60	80	13	80	40	100
CM+	98	78	16	80	35	100
<b>pride</b>						
CM–	60	51	25	55	00	90
CM+	98	44	25	45	00	90
<b>anger</b>						
CM–	60	75	16	80	25	100
CM+	98	71	17	75	10	95
<b>contempt</b>						
CM–	60	41	21	40	00	85
CM+	98	38	22	40	00	85
<b>disgust</b>						
CM–	60	58	19	58	15	95
CM+	98	52	23	58	00	100
<b>embarrassment</b>						
CM–	60	64	15	65	25	90
CM+	98	63	16	65	05	95
<b>fear</b>						
CM–	60	54	22	55	10	95
CM+	98	48	22	55	00	95
<b>sadness</b>						
CM–	60	70	19	70	10	95
CM+	98	65	19	70	05	100
<b>neutral</b>						
CM–	60	86	16	92	35	100
CM+	98	82	15	85	30	100

Note: Each emotion was shown  $n = 20$  times. CM+: child maltreatment group; CM–: non child maltreatment group.