

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

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1 ABSTRACT

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

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

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

16 *Results:* The CM+ showed significantly lower scores in the recognition of positive, negative
17 and neutral facial expressions than the CM- group ($p < 0.050$). Furthermore, the CM+ group
18 showed a negativity bias for neutral facial expressions ($p < 0.001$). When accounting for
19 mental disorders, significant effects stayed consistent, except for the recognition of positive
20 facial expressions: individuals from the CM+ group with but not without mental disorder
21 scored lower than controls without mental disorder.

22 *Conclusions:* CM might have long-lasting influences on the ER abilities of those affected.

23 Future research should explore possible effects of ER alterations on everyday life, including

24 implications of the negativity bias for neutral facial expressions on emotional wellbeing and
25 relationship satisfaction, providing a basis for interventions that improve social functioning.

26 *Keywords:*

27 Facial emotion recognition, Child maltreatment, Negativity bias, Neutral expressions, mental
28 disorders

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30

31 **Highlights**

32 • Child maltreatment (CM) in adults is linked to emotion recognition alterations if no current
33 mental disorders are present

34 • Interpretation of positive, negative and neutral facial expressions is impaired

35 • Adults with a history of CM tend to interpret neutral expressions as negative

36

37 **1. Introduction**

38 Child maltreatment (CM) is common, affecting 16-23% of the global population (1).
39 It is defined as (sexual, physical or emotional) abuse and/or (physical or emotional) neglect
40 of children that occurs within a relationship of responsibility, trust or power (2). Next to a
41 strong link between CM and impaired physical health (3-5), individuals who experienced CM
42 are vulnerable to develop mental disorders in adulthood (6,7). Many adults with
43 schizophrenia (56.1%), bipolar disorder (56.3%), persistent depressive disorder (75.4%), and
44 major depressive disorder (57.1%) report having experienced CM (8). Additionally, adults
45 with CM experiences have a significantly greater likelihood of being diagnosed with
46 personality disorders, mood disorders, and post-traumatic stress disorder (PTSD) (for review
47 see 9). Moreover, they suffer from long-term effects of CM on social functioning such as low
48 relationship satisfaction, higher rates of separation, problematic parenting behaviors, intimate
49 partner aggression and violence (10-13), reduced perceptions of social support and increased
50 perceptions of loneliness and social isolation (14). To date, there is limited knowledge on the
51 processes that underlie these long-term social impairments. Given that positive social
52 relationships can protect from the development of trauma-related (15) and other mental and
53 physical disorders (6-18), it is important to identify the processes that might contribute to
54 broader social impairments, which will increase the capacity to intervene therapeutically (19).
55 One area that might contribute to these deficiencies is impaired learning of emotion
56 processing such as recognition, communication, interpretation, and regulation of emotions
57 (20).

58 Although the number of studies that have assessed effects of CM on ER in adults is
59 scarce, there has been some evidence of long-term ER alterations. Catalan et al. (2020) (21)
60 found that adults with a history of CM attribute expressions of anger and fear more frequently
61 to neutral and happy faces. Likewise, Pfaltz et al. (2019) (22), who examined adults with

62 PTSD, discovered that individuals with high compared to low levels of CM were particularly
63 prone to misinterpret neutral expressions as negative (i.e., anger, contempt, and sadness).
64 Similarly, in their recent systematic review, Berube et al. (2021) (23) reported that CM is
65 related to an increased recognition of negative emotions like fear and anger, while the
66 recognition of happy facial expressions is impaired. In sum, there is evidence that in adults,
67 CM is linked to ER alterations as well as to a tendency to interpret facial expressions as
68 negative (negativity bias).

69 As populations with CM experiences are characterized by high rates of mental
70 disorders (6-8), research on ER has focused on individuals with CM suffering from a specific
71 mental disorder and found alterations in ER within this population. Berube et al. (2021)
72 reported that 33% of the studies included in their review examined the combined effect of
73 CM and mental illness, 21% excluded participants with current or past mental illness and
74 46% did not report information about participants' mental health altogether. In addition,
75 previous studies have rarely focused on the recognition of neutral facial expressions. In the
76 review by Berube et al. (2021), only two out of 11 studies that included neutral facial
77 expressions used an ER task, rather than an attention, matching, or gender identification task.
78 In one of the two studies, participants were mothers with vs. mothers without CM without
79 current mental disorders and psychopharmacological treatment (24). The other of the two
80 studies examined patients with depression and healthy controls with vs. without a history of
81 CM (25). Hence, findings from previous studies may not generalize to the population of
82 individuals with a history of CM and it is unclear whether alterations in the recognition of
83 facial expressions are related to CM, to the presence of mental disorders or to the
84 combination of CM and mental disorders (23). Moreover, the correct interpretation of neutral
85 facial expressions is crucial as in our everyday lives, facial expressions might often be neutral
86 (26). Thus, further studies are needed that examine possible alterations in the interpretation of

87 neutral facial expressions in a population that is representative for individuals with CM
88 experiences, rather than recruiting individuals with a specific mental disorder who, in
89 addition, report a history of CM.

90 Finally, previous studies commonly used static stimuli (e.g., still pictures), presented
91 with high intensity to assess ER, making it difficult to generalize results to real-life situations,
92 where emotions are displayed dynamically. In the review by Berube et al. (2021), only one of
93 24 studies included videos instead of still pictures. Five of the studies transformed the
94 pictures to provide participants with a gradual display of emotions. Yet, in real life, emotions
95 are commonly more subtle (27, 28). Thus, a replication of previous findings with ecologically
96 more valid stimuli is needed to better understand ER in individuals with CM.

97 The present study hence pursued three goals. First, to recruit a sample of adults with a
98 history of CM (CM+) and compare it to a sample of adults without a history of CM (CM-),
99 rather than recruiting participants with a specific mental disorder, with and without a history
100 of CM. Second, to assess the ability to recognize neutral (next to negative and positive) facial
101 expressions. Third, to employ dynamic stimuli that are as close to real life situations as
102 possible. We hypothesized that the CM+ group would achieve lower recognition rates for
103 positive and neutral expressions, and higher recognition rates for negative expressions than
104 unexposed individuals. Further, we hypothesized that the CM+ group would show a greater
105 negativity bias (tendency to label neutral facial expressions as negative) than unexposed
106 individuals. Finally, we explored whether the hypothesized group differences would remain
107 significant when accounting for the presence of mental disorders.

108 **2. Method**

109 *2.1. Participants*

110 Participants were recruited from a study pool, by means of online advertising, and in
111 collaboration with out-patient clinics in the area of Zurich. The study was approved by the

112 local ethics committee (Kantonale Ethikkommission Zürich). All participants provided written
113 informed consent. Inclusion criteria were: 1) age between 18 and 65 years, 2) normal eyesight
114 (or corrected). Exclusion criteria were: 1) insufficient knowledge of German language, 2)
115 substance abuse (current or during the last 12 months), 3) acute suicidality (assessed during
116 screening visit), 4) psychotic symptoms (current or past), 5) current intake of medication with
117 a potential influence on psychophysiological measurements (e.g., beta blocker) recorded in a
118 separate study that was part of an overarching project, 6) severe medical conditions affecting
119 psychophysiological measurements of the separate study, 7) pregnancy, 8) placement in
120 children's home or similar institution for at least 1 year during the first 18 years of age
121 (exclusion criterion for the separate study).

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

126 *Table 1*

127 2.2. Psychological assessment

128 CM was measured using the *German version of the Childhood Trauma*
129 *Questionnaire-Short Form (CTQ-SF; (29), in German translation and validation of (30, 31).*
130 The CTQ is widely used (by 67% of the studies in the review by Berube et al. (2021)).
131 Internal consistency for the subscores is high ($\alpha > .81$), except for the physical neglect
132 subscale ($\alpha = 0.49$). Participants with a CTQ rating higher than "none / minimal" in at least
133 one of the subscales according to (32) (i.e., ≥ 10 for emotional neglect, ≥ 8 for physical
134 neglect, ≥ 9 for emotional abuse, ≥ 8 for physical abuse and ≥ 6 for sexual abuse) were

135 included in the CM+ group. The CM- group comprised individuals with “none / minimal”
136 CTQ ratings on all subscales.

137 To characterize the sample, we assessed 1) Depressive symptoms, using the German
138 version of the *Beck Depression Inventory (BDI; (33)*, in German translation of Beck & Steer,
139 1987 (34)). The BDI comprises 21 self-report items, assessing the severity of depressive
140 symptoms over the past week. The BDI has good validity and reliability (33). 2) The number
141 of experienced trauma types using the trauma checklist of the *Post-Traumatic Diagnostic*
142 *Scale for DSM-5 (PDS-5; (35)*, non-published adapted German version by Elbert et al.,
143 University of Konstanz). The PDS-5 demonstrates excellent internal consistency and test–
144 retest reliability, and good convergent validity with the PTSD Checklist - Specific Version
145 and the PTSD Symptom Scale - Interview Version for DSM–5 (35). 3) Current mental
146 disorders (anxiety disorders, obsessive-compulsive disorders, PTSD, eating disorders), using
147 a semi-structured German diagnostic interview for mental disorders (*Diagnostisches*
148 *Interview bei Psychischen Störungen for DSM-5 (DIPS)*, (36), showing good reliability (37).
149 4) Personality disorders, using the German version of the *Structured Clinical Interview for*
150 *DSM-IV*, axis II (personality disorders) (*SKID-4; (38)*), showing adequate interrater and
151 internal consistency reliability (39).

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

156 2.3. Facial ER paradigm

157 We used the Amsterdam Dynamic Facial Expression Set - Bath Intensity Variations
158 (ADFES-BIV) as stimuli, which was adapted from the ADFES (40) and subsequently

159 validated in a sample of 92 healthy participants (27). The ADFES-BIV comprises 360 non-
160 manipulated, coloured video sequences of facial expressions by 12 Northern European
161 encoders (7 male, 5 female) and 10 practice videos by 10 Mediterranean encoders (5 male, 5
162 female); each 1040ms in duration. This relatively short time period corresponds to everyday
163 situations, in which individuals are usually confronted with short emotional expressions.

164 We used 200 stimuli from the ADFES-BIV (10 encoders (5 female, 5 male) x 9
165 emotions (anger, sadness, embarrassment, contempt, fear, disgust, joy, surprise, pride) and 20
166 neutral facial expressions) and presented them in the SR Research Experiment Builder
167 software. Each video displayed the face of an encoder that changed from a neutral expression
168 into one of the eight emotional expressions or remained neutral. Next, a list of the nine
169 emotional expressions and neutral appeared and the participants were asked to indicate with a
170 mouse click which expression had been presented (emotion labelling).

171 *2.4. Procedure*

172 The study was part of a larger project that investigated physical and socio-emotional
173 consequences of CM. Study procedures comprised three laboratory appointments. At visit 1,
174 participants signed written informed consent and graduate psychology students, trained and
175 supervised by an experienced licensed psychotherapist (last author), assigned the
176 questionnaires and conducted clinical interviews (CTQ-SF, BDI, PDS-5, DIPS, SKID-4). At
177 visit 2, participants completed the above described ER paradigm (27), as well as an emotion
178 induction paradigm and a personal space paradigm. At visit 3, participants' responses to
179 intimacy were assessed (41). Participants were reimbursed with 20 Swiss Francs per hour.

180 *2.5. Statistical analyses*

181 The analysis of the emotion surprise of the ER paradigm was left out, as surprise
182 cannot clearly be assigned to the positive or negative category. Furthermore, for all statistical

183 analyses, the two emotion intensity levels (1 and 3) were taken together as for the separate
184 intensity levels, there was not enough stimulus material and therefore, the dispersion of the
185 data was too large. The remaining emotional expressions were divided into three categories
186 (dependent variables): positive (joy, pride), negative (anger, fear, sadness, disgust, contempt,
187 and embarrassment), and neutral. Group differences in ER of correctly identified positive,
188 negative, and neutral emotional expressions were calculated using R version 4.2.1 (2022-06-
189 23). First, three variables were calculated: percentage of correctly identified positive
190 expressions, percentage of correctly identified negative, and percentage of correctly identified
191 neutral expressions. If a participant identified a positive emotion as another positive emotion
192 (or a negative emotion as another negative emotion), this was counted as “false”. Data of the
193 positive condition was well modelled by a normal distribution according to Shapiro-Wilk's
194 normality test ($W = 0.983$, $p = .053$). Data of the negative ($W = 0.981$, $p = .026$), and of the
195 neutral condition were not well modelled ($W = 0.868$, $p < .001$) by a normal distribution. The
196 Levene's test for homogeneity of variance suggested homogeneity in the variables of all three
197 conditions ($p > .471$) and no outliers were detected by box-whisker-plots. To assess whether
198 the two study groups differ in the number of correct responses (correctly identified stimuli –
199 e.g., anger identified as anger), Mann-Whitney-U tests were calculated for positive, negative,
200 and neutral emotion trials separately. Additionally, to test the influence of current mental
201 disorder (according to the SKID-4 and the DIPS), separate t-tests for mean percentage rates
202 of positive trials and Mann-Whitney-U tests for neutral and negative trials were conducted
203 for comparison of the CM- and the CM+ group. Groups were compared three ways:
204 participants of CM+ and CM- without one or more current mental disorder ($n = 48$, $n = 49$),
205 participants of the CM+ group without current mental disorder with participants of the CM+
206 group with current mental disorder ($n = 45$), and the CM+ with current mental disorder with
207 the CM- group comprising of participants without current mental disorder. Two separate

232 Participants of the CM+ achieved generally lower ER rates than participants of the
233 CM- group. Mann-Whitney-U tests revealed significant group differences in the recognition
234 of positive ($U = 2368.5$ ($p_{\text{one-tail}} = .020$)), negative ($U = 2250.50$ ($p_{\text{one-tail}} = .007$)), and neutral
235 ($U = 2410.00$ ($p_{\text{one-tail}} = .027$)) facial expressions. Significant differences in the recognition of
236 negative and neutral facial expressions persisted when comparing the CM+ without mental
237 disorder with the CM- group without mental disorder ($U = 1444$, $p = .027$ for negative; $U =$
238 1428 , $p = 0.033$ for neutral). Participants of the CM+ with mental disorder did not show
239 significantly different scores than participants from the CM+ group without mental disorder
240 (negative expressions: $U = 1174$, $p = .295$; neutral expressions: $U = 1197.5$, $p = .235$) but
241 they did show significantly different scores than the CM- group without mental disorders
242 (negative expressions: $U = 1434$, $p = .003$; neutral expressions: $U = 1313$, $p = .035$). For the
243 recognition of positive facial expressions, only participants from the CM+ with ($t[90.35] =$
244 2.56 , $p = .006$) but not participants from the CM+ group without mental disorders ($t[88.83] =$
245 ± 0.01 , $p = .504$) showed lower scores than participants from the CM- group without mental
246 disorders. Participants from the CM+ with mental disorders showed lower scores than
247 participants from the CM+ group without mental disorders ($t[89.01] = 2.92$, $p = .002$). Group
248 differences are illustrated in Figure 2, as summary statistics of ER mean percentage rates by
249 group and mental disorder for each condition (positive, negative, and neutral). Results did not
250 change when ($n = 24$) images with low recognition rates ($< 33\%$) were excluded from the
251 analyses (p 's $< .029$ for significant results, p 's $> .206$ for non-significant results).

252 *Figure 2*

253 3.2. Negativity bias by group

254 The GLMM with the negativity shift defined as “subject answered negative instead of
255 neutral” revealed a significant group difference ($OR = 0.75$, $p < 0.001$ with a $CI = 0.7450 -$

256 0.7466). The CM+ group interpreted neutral facial expressions significantly more often as
257 negative as the CM- group. Adding the factor mental disorders to the model had a significant
258 effect on the negativity shift ($OR = 1.05, p < 0.001$ with a $CI = 1.05 - 1.05$), with the group
259 effect (CM+/CM-) remaining significant ($OR = 0.79, p < 0.001$ with a $CI = 0.79 - 0.79$).
260 Individuals out of the CM+ group with current mental disorder had a stronger negativity bias
261 than those without current mental disorder. The GLMM to identify a general negativity bias
262 revealed no significant group differences ($OR = 0.87, p = 0.217$ with a $CI = 0.69 - 1.09$). The
263 factor mental disorders did not have a significant effect on the general negativity bias ($OR =$
264 $0.68, p = .136$ with a $CI = 0.40 - 1.13$). Participants of the CM+ group with current mental
265 disorder did not show a stronger general negativity bias than participants of the CM+ group
266 without current mental disorder.

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

272 **4. Discussion**

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

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

282 4.1. ER alterations

283 General ER deficits have been identified in several prior studies assessing *children*
284 exposed to CM (45, 46). However, our finding of global ER alterations in *adults* exposed to
285 CM is somewhat surprising. In contrast to studies with children, previous studies with adult
286 populations mainly pointed to increased recognition rates for negative emotions (23).
287 Contradictory findings might be explained by differences in study samples and in the applied
288 ER paradigms. English et al. (2018) (47) for example found that CM was related to increased
289 recognition of fear. Their research was conducted with female undergraduate students ($M =$
290 18.98 years) with exposure to emotional maltreatment. This finding might therefore not
291 translate to a more representative CM population, including male and older individuals or
292 individuals with other types of CM experiences, which frequently co-occur (48). Gibb et al.
293 (2009) (49) found an attention and interpretation bias for angry faces in young adults ($M =$
294 19.24 years) with a history of childhood abuse. However, the authors did not assess the
295 influence of neglect, and used photographs rather than dynamic ER stimuli. The dynamic
296 stimulus set used in the current study might be more sensitive in detecting ER alterations than
297 a static stimulus set, given that emotions displayed with high intensity are less difficult to
298 identify (50). Hence, previous studies with static intense stimuli may not have captured the
299 full range of alterations.

300 Importantly, significant group differences for the recognition of neutral and negative
301 facial expressions detected in the current study persisted when accounting for mental
302 disorder. This finding might emphasize that CM specifically affects the recognition of neutral
303 and negative but not of positive facial expressions, for which the difference between the CM-

304 and the CM+ group was no longer significant when assessing only participants without
305 mental disorder.

306 *4.2. Negativity bias*

307 We found no general negativity shift in the interpretation of facial expressions but
308 rather, and in line with findings by Pfaltz et al. (2019) and Catalan et al. (2020), the
309 negativity bias was confined to neutral facial expressions. That is, a specific negativity bias
310 for neutral facial expressions was found, rather than a general negativity shift. Even though
311 the negativity bias for neutral facial expressions was strongest in the CM+ group with current
312 mental disorder, the group effect stayed significant. That is, both, individuals with CM
313 experiences with and without mental disorder, showed a negativity bias for neutral facial
314 expressions. As neutral expressions may precede, accompany, or follow sexual or physical
315 abuse by the perpetrating caregivers (51), neutral expressions might not be considered
316 trustworthy by individuals with CM experiences. Negative schemas might influence the
317 perception and interpretation of facial expressions. Schemas are belief patterns, developed in
318 early childhood through past behaviours and experiences, which are thought to correspond to
319 unmet needs in childhood relationships with significant others (52, 53). In fact, schemas in
320 adulthood are associated with a history of abuse and neglect during childhood and
321 adolescence (53). Moreover, in individuals with experiences of emotional and/or physical
322 neglect, non-emotional facial expressions may represent a caregiver's lack of responsiveness
323 and thus be perceived as aversive. While such learning processes might be adaptive in the
324 original, maltreating environment of a child, they might contribute to interpersonal problems
325 when persisting into adulthood and exert negative effects on social interactions and
326 relationships. In fact, a high percentage of our sample suffered from personality disorders,
327 which are characterized by interpersonal difficulties.

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

333 *4.3. Limitations and conclusions*

334 A first limitation is that in our ER paradigm, which is in line with most paradigms
335 (23), more negative (anger, sadness, fear, disgust, contempt, embarrassment) than positive
336 (happiness, pride) emotions were presented. Thus, neutral expressions had a higher chance to
337 be confused with negative compared to positive expressions. Given the significant group
338 difference in the percentage of negatively (mis)identified neutral expressions, our results
339 nonetheless speak for a negativity bias in CM+ compared to CM-. Still, future research
340 studies should assess whether the observed negativity bias for neutral expressions can be
341 replicated when presenting the same number of positive and negative
342 expressions. Furthermore, the retrospective self-report assessment of CM by adults using the
343 CTQ is a limitation, as it has been shown that prospective and retrospective measures of CM
344 identify different groups of individuals (54). The CTQ is also a rather sensitive measure. In
345 particular, the emotional neglect and sexual abuse subscales have cut-off scores that can
346 easily be reached. In some instances, participants were assigned to the CM+ group if they
347 reported experiences such as their parents' separation which had created a non-loving or non-
348 caring family atmosphere during a particular time of their lives, or isolated events that were
349 not experienced as stressful (e.g., being exposed to an exhibitionist that was unknown to
350 them). In other words, a few participants ended up in the CM+ group that reported
351 experiences which may not constitute CM. Furthermore, the exclusion criteria (certain
352 medications, individuals who were removed from their homes because of maltreatment)

353 might affect the generalizability of our results. Nevertheless, the sample of the current study
354 reported levels (severity) of CM that are comparable to previous studies (e.g., (47, 49, 55)).
355 Another limitation is the size of the subgroups in our sample (e.g., larger subgroups with
356 anxiety/personality disorders), which makes it difficult to ascribe our results to a general
357 effect of mental disorder, or rather a specific mental disorder as for example anxiety disorder.
358 Larger samples and subgroups are needed to investigate this further. Moreover, some authors
359 (56) have recently challenged the meaning of “emotion recognition” and favour the term
360 “emotion reasoning” instead, which encompasses the ability of children to use expressive
361 behaviours, contextual information, and their own learning histories to make reasonable and
362 adaptive inferences and predictions about other people’s internal states and future behaviours.
363 Future research should take this new definition into consideration and assess socio-emotional
364 skills and their interplay more broadly. Finally, we cannot conclusively say if participants
365 misclassified negative emotions to neutral expressions or if this is rather an artifact of general
366 “non-emotional” classification processes, since we – like most other ER studies researching
367 individuals with CM experiences (e.g., 21, 22, 57) did not include a geometric control
368 condition. Future studies should thus include such a control condition as is common in MRI
369 studies researching consequences of CM experiences (e.g., 58-60).

370 Our study using a dynamic stimulus set of emotions extends previous findings on a
371 negativity bias towards neutral facial expressions (21, 22), which does not seem to be
372 restricted to PTSD or other mental illnesses in individuals with a history of CM. Together
373 with broader problems in the recognition of negative and positive expressions, this might
374 result in interpersonal problems and consolidate unfavourable past emotional experiences and
375 corresponding schemas (53). Hopefully future research will contribute to better understand
376 social problems in individuals affected by CM, and to develop effective interventions that
377 improve social functioning.

378 Data availability statement

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

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