

Appendix 1 to Neukel C, Bertsch K, Fuchs A, et al. The maternal brain in women with a history of early-life maltreatment: an imagination-based fMRI study on conflictual vs. pleasant interactions with children. *J Psychiatry Neurosci* 2018.

DOI: 10.1503/jpn.170026

© 2018 Joule Inc., or its licensors

Online appendices are unedited and posted as supplied by the authors.

Online Supplementary Information

Participants

The present study was performed within the framework of the UBICA study (“Understanding and Breaking the Intergenerational Cycle of Abuse”). The UBICA study is a multi-center study investigating the effects of maternal early life maltreatment and maternal mental disorders on mother-child interaction and child wellbeing and development (Kluczniok et al., 2015; Mielke et al., 2016; Fuchs, et al., 2016; Hillmann et al., 2016). Thus, samples across UBICA studies show overlap in participants.

Mothers of the population-based sample were recruited via advertisements in newspapers and web pages, via flyers in pediatric and gynecologist practices, as well as letters sent to participants of a former population-based study on mother-child interaction (Moehler et al., 2007) and to random samples of local inhabitants (3000 letters). In total, 276 mothers showed interest in the study and were contacted via telephone to give them more information on the study and to be screened for eligibility. Finally, 89 (N=37 without and N=52 with ELM) mother-child dyads were included in the study. Mothers were included in the fMRI study if they did not show any exclusion criteria for the fMRI measurement (metal parts in the body, claustrophobia, permanent make up, current pregnancy). Originally, N=30 mothers with and N=29 mothers without ELM took part in the fMRI study. Due to technical problems with the in-ear headphones the script-driven imagery paradigm could not be administered to two participants resulting in a sample of N=29 mothers with and N=28 mothers without a history of ELM. 10 of these participants then had to be excluded due to head movement (see below).

None of the 47 mothers included in the analyses presented here suffered from a current mental disorder (in accordance with the exclusion criteria); nine mothers with ELM had lifetime diagnoses of a mental disorder: N=4 MDE, N=1 MDE and PTSD, N=1 MDE and eating disorder, N=1 MDE and panic disorder, N=1 bipolar II disorder, N=1 eating disorder.

Procedure

| | Participants | Measure | Variable of Interest |
|----|---------------------|---|--|
| 1. | Mother and Child | real-life mother child interaction, EA Scales (Biringen, 2008) | maternal sensitivity |
| 2. | Mother | diagnostic interviews: - CECA - SCID-I - IPDE - HAM-D | - Early life maltreatment - Past and current diagnoses of mental disorders - Diagnoses of personality disorders - Current depressive symptoms |
| 3. | Mother | fMRI: script-driven imagery paradigm | BOLD response to imagined mother-child interactions |

Appendix 1 to Neukel C, Bertsch K, Fuchs A, et al. The maternal brain in women with a history of early-life maltreatment: an imagination-based fMRI study on conflictual vs. pleasant interactions with children. *J Psychiatry Neurosci* 2018.

DOI: 10.1503/jpn.170026

© 2018 Joule Inc., or its licensors

Online appendices are unedited and posted as supplied by the authors.

Measures

To assess *maternal sensitivity*, the capacity to adequately respond to children's cues, mother-child dyads were videotaped during a 15min free play and a 6min task phase and the mother-child interaction was coded by trained and independent raters according to the emotional availability scales (EAS; Biringen, 2008). The maternal sensitivity scale ranges from 1 (highly insensitive) to 7 (highly sensitive). According to the EAS, a mother with high sensitivity withholds a positive, creative, authentic, and congruent communication throughout the whole observed period. Contrary to this, a highly insensitive mother shows no sign of positive communication, either because there is no contact between mother and child, both are refusing contact, or the child is being neglected or beaten by the mother (Biringen et al., 2012). According to Biringen (see Biringen, 2008), mothers scoring above 4 are "good enough" to give those relationships a clean bill of health. Scores of 4 and lower describe mothers not showing a healthy style of relating. Inter-rater reliability was assessed using Cronbach-Alpha and ranged from $\alpha=.81$ to $\alpha=.88$.

Script-driven imagery paradigms in the fMRI environment are used to provoke symptoms and induce emotional states with the goal to study underlying neural circuits of symptoms (e.g. dissociation) and emotion-processing (Lanius et al., 2007; Ludaescher et al., 2010; Frewen et al., 2011). Participants are asked to imagine the situations described in the scripts as vividly as possible and as if what is being described is actually happening in the present. In the present task we used standardized scripts in order to induce emotional states occurring in mother-child interactions. The scripts were developed with women who had children in the age of the targeted study sample and read in a neutral tone by a professional actress. Scripts were matched for the four conditions conflictual-own, conflictual-unfamiliar, pleasant-own and pleasant-unfamiliar in a way that the same interactions were described for the own and an unfamiliar child and that conflictual and pleasant interactions contained the same modality (e.g. hands were used in both scripts). The choice of 15sec for the imagination phase in our study is based on a behavioral trial we conducted with the script-based imagination paradigm before the actual study: We presented the scripts read in a neutral tone by an actress to women who had children in the age of the targeted study sample and asked them how long they needed to imagine the described mother-child interaction and whether they let their mind wander. 15 sec showed to be sufficient to imagine the script and not too long to let the mind wander.

Here are examples of two scripts:

Pleasant interaction with own child (female): "School is closed today so I take my daughter and her friend to town. We enter a bakery, because I need to buy some bread. My daughter says that she would like a pretzel. I buy a bread and a pretzel. My daughter thanks me for the pretzel and grasps it."

Conflictual interaction with unfamiliar child (male): "I am on vacation with my son and his friend. They both watch TV. I tell my son's friend to finally tidy up his clothes which are spread all over the room – but he ignores me. When I raise my voice warning him for the third time he shouts 'shut your mouth' and throws the remote control towards me."

fMRI analysis

Preprocessing. The functional images of each participant for each session were realigned and unwrapped. Afterwards, the functional scans were co-registered to the individual segmented anatomical images, spatially normalized to Montreal Neurological Institute space, resampled with a voxel size of $3 \times 3 \times 3 \text{mm}^3$, and smoothed by a three-dimensional Gaussian kernel (full-width-at-half-maximum

Appendix 1 to Neukel C, Bertsch K, Fuchs A, et al. The maternal brain in women with a history of early-life maltreatment: an imagination-based fMRI study on conflictual vs. pleasant interactions with children. *J Psychiatry Neurosci* 2018.

DOI: 10.1503/jpn.170026

© 2018 Joule Inc., or its licensors

Online appendices are unedited and posted as supplied by the authors.

8mm). Participants were discarded from further analysis when showing head movements more than 3mm from volume to volume or rhythmical head movement that could interfere with the task. The rather high number of exclusions because of head movement (10 participants) could be due to the emotional arousal that mothers reported during execution of the task.

gPPI analyses. Seed regions in insula and amygdala for the gPPI analyses were defined as a 2mm radius sphere around the peak activity of the contrast identifying regions that are significantly more activated in mothers with ELM compared to CON mothers when imagining conflictual vs. pleasant interactions with their own child.

Appendix 1 to Neukel C, Bertsch K, Fuchs A, et al. The maternal brain in women with a history of early-life maltreatment: an imagination-based fMRI study on conflictual vs. pleasant interactions with children. *J Psychiatry Neurosci* 2018.

DOI: 10.1503/jpn.170026

© 2018 Joule Inc., or its licensors

Online appendices are unedited and posted as supplied by the authors.

References

Moehler, E., Biringen, Z., & Poustka, L. (2007). Emotional availability in a sample of mothers with a history of abuse. *American Journal of Orthopsychiatry*, 77(4), 624.

Biringen, Z (2008). *The Emotional Availability (EA) Scales*, 4th edition. Published by emotionalavailability.com, PO Box, 3625, Boulder, Colorado, 80307.

Biringen, Z., & Easterbrooks, M. A. (2012). Emotional availability: Concept, research, and window on developmental psychopathology. *Development and psychopathology*, 24(01), 1-8.

Lanius, R.A., Frewen, P.A., Girotti, M., Neufeld, R.W., Stevens, T.K., & Densmore, M. (2007). Neural correlates of trauma script-imagery in posttraumatic stress disorder with and without comorbid major depression: a functional MRI investigation. *Psychiatry Research: Neuroimaging*, 155(1), 45-56.

Ludaescher, P., Valerius, G., Stiglmayr, C., Mauchnik, J., Lanius, R.A., Bohus, M., Schmahl, C. (2010). Pain sensitivity and neural processing during dissociative states in patients with borderline personality disorder with and without comorbid posttraumatic stress disorder: a pilot study. *Journal of psychiatry & neuroscience: JPN*, 35(3), 177.

Frewen, P.A., Dozois, D.J., Neufeld, R.W., Densmore, M., Stevens, T.K., Lanius, R.A. (2011). Neuroimaging social emotional processing in women: fMRI study of script-driven imagery. *Social cognitive and affective neuroscience*, 6(3), 375-392