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Disinhibited reactive attachment disorder symptoms impair social judgements from faces

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ABSTRACT

Typically developing adults and children can rapidly reach consensus regarding the trustworthiness of unfamiliar faces. Maltreated children can have problems with trusting others, yet those with the disinhibited form of reactive attachment disorder (dRAD) can be indiscriminately friendly. Whether children with dRAD symptoms appraise and conform to typical judgements about trustworthiness of faces is still unknown. We recorded eye movements of 10 maltreated dRAD children and 10 age and gender matched typically developing control children while they made social judgements from faces. Children were presented with a series of pairs of faces previously judged by adults to have high or low attractiveness or trustworthiness ratings. Typically developing children reached a consensus regarding which faces were the most trustworthy and attractive. There was less agreement among the children with dRAD symptoms. Judgments from the typically developing children showed a strong correlation between the attractiveness and trustworthiness tasks. This was not the case for the dRAD group, who showed less agreement and no significant correlation between trustworthiness and attractiveness judgments. Finally, both groups of children sampled the eye region to perform social judgments. Our data offer a unique insight in children with dRAD symptoms, providing novel and important knowledge for their rehabilitation.

1. Introduction

We present novel data regarding evaluation of faces in maltreated children suffering from symptoms of reactive attachment disorder (RAD). A core clinical characteristic of RAD is indiscriminate friendliness and we wished to investigate whether or not this was associated with atypical appraisal of faces by these children—especially as regards the evaluation of trustworthiness, a key deficit in the RAD syndrome.

1.1. Reactive attachment disorder

Reactive attachment disorder (RAD) is a serious disorder of social functioning associated with maltreatment with two subtypes: Inhibited (wary, watchful behaviour) and Disinhibited (overfriendly behaviour).[2] The Disinhibited form (that we focus on in this paper) is known to be associated with significant psychiatric morbidity (Rutter et al., 2007) and can persist despite changes in care giving context (Gleason et al., 2011). The core characteristic of Disinhibited RAD (dRAD) is indiscriminate friendliness. We have already shown that children with indiscriminate friendliness can have complex neurodevelopmental problems including multiple psychiatric comorbidities (Kocovska et al., 2012). Children with indiscriminate friendliness are significantly socially impaired: despite being aware of the risks associated with speaking to strangers and the efforts made by their caregivers to protect them from danger, they demonstrate "a trust of new people and a craving for kindness from others" which may introduce them to further risky situations (Bennett et al., 2009).

1.2. How does trust develop in childhood?

Trust "is essential to initiate, establish, and maintain social relationships [and] encourages the initiation of mutual cooperative relationships" (Balliet and Van Lange, 2013). A sense of trust develops in the context of a secure attachment relationship with parents (Corriveau et al., 2009) and behavioural genetic research has shown that development of a sense of trust in family members

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[2] Please note the dRAD is labelled Social Engagement Disorder in the DSM-V. We are keeping the appellation dRAD throughout the manuscript for clarity and consistency with previous literature.

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and peers is based largely on environmental, rather than genetic factors. A sense of trust is an important buffer against life stressors and can reduce the likelihood of problems such as isolation or bullying in school and the development of depression (Sakai, 2010). It is also associated with prosocial (i.e. caring, helpful) behaviour (Rotenberg et al., 2004) and with academic achievement (Goddard, 2003).

While very young children (aged 3 or 4) have difficulty discriminating between "helpers" and "trickers" in experiments, by age 5 typically developing children are systematically more likely to take advice from individuals who have previously proven helpful (Vanderbilt et al., 2011). By middle childhood, therefore, typically developing children are not indiscriminately trusting. Harris and Corriveau (2011) argue that "indiscriminate credulity is implausible, both biologically and psychologically".

Yet indiscriminate friendliness is a relatively common phenomenon in children who have experienced maltreatment (Rutter et al., 2009). Lieberman has suggested that a basic problem for maltreated children is the sense of mistrust that has emerged from their lack of a predictable, loving caregiver in early childhood and that this lack of trust is associated with a range of difficult behaviours including indiscriminate friendliness (Lieberman, 2003). We have previously suggested that indiscriminate friendliness might develop out of "discordant intersubjectivity" between a child and a maltreating caregiver in early life: in a secure attachment relationship, a concordant intersubjective relationship results in the development of "in-jokes" and other highly personal codes shared between the child and caregiver. These will soon lead to a preference for caregiver over strangers. In a maltreating relationship characterised by discordant clashes and failed attempts at interaction, relationships with strangers may seem at least as satisfying – or even preferable (Minnis et al., 2006). A qualitative study of maltreated, indiscriminately friendly children supported this view: despite being grossly over-inclusive in those they regarded as "friends", these children were also preoccupied with issues of trust (Bennett et al., 2009).

In typical development, very rapid judgements about faces are possible (after less than 100 ms exposure to a face) based on a range of factors such as trustworthiness, competence and aggressiveness (Willis and Todorov, 2006). Oosterhof and Todorov (2008) argue that cues about whether to avoid or approach an individual are important in making social decisions, even though such decisions may be based on rather crude information.

Despite the associations between maltreatment, lack of a sense of trust/indiscriminate friendliness and poor social, academic and psychological outcomes, little is known about the mechanisms involved during childhood. One possibility is that these difficulties originate in a basic problem with visual processing of faces. The other disorder well known to be associated with severe problems in social interaction is Autism Spectrum Disorder (ASD) and there is already a body of research investigating visual processing of faces ASD. Some eye-tracking studies in ASD have shown reduced fixations on socially salient aspects of visual scenes (Noris et al., 2012; Pierce et al., 2011; Riby and Hancock, 2009; Rice et al., 2012) and there are reports that individuals with ASD look less at facial features (eyes, nose, mouth) than typically developing peers (Chawarska and Shic, 2009; Pelphrey et al., 2002). Other studies suggest a more complex picture with mixed results depending on the cognitive sub-phenotypes in ASD (Norbury et al., 2009; Rice et al., 2012).

It is important to note that, in most of these studies, results were analysed using a "Regions-Of-Interest" (ROI) approach. The most critical limitations of such an approach rely on the fact that the subjective criteria used to define ROIs compromise the potential to replicate findings across studies (Caldara and Miellet, 2011). Other factors might explain inconsistencies across studies such as type of stimuli, task, subgroups of ASD observers, etc. For instance, the atypical fixation pattern in children with ASD is more pronounced in natural social settings than in experimental settings with isolated stimuli. As yet, the precise impact of ASD on visual exploration of socially relevant stimuli is not completely understood.

In summary, the extant literature suggests that the ability to discriminate rapidly between trustworthy and untrustworthy individuals typically develops in the preschool period and the development of a sense of trust appears to be largely environmentally (rather than genetically) determined. Maltreated children with indiscriminate friendliness are insecure about relationships, lack trust and appear unable to make the correct judgements about who they should and should not trust. Our knowledge about the mechanisms of trustworthiness judgements largely comes from studies in typically developing adults and it has been shown that such adults are able to rapidly come to a consensus, based on facial traits, about who should be judged trustworthy and who should not.

To the best of our knowledge, appraisals of trustworthiness in children with indiscriminate friendliness have not yet been investigated. In this study we wished to ask whether, like adults, typically developing children come to a consensus about which faces are trustworthy or untrustworthy; whether maltreated children with indiscriminate friendliness suffering from dRAD are able to make similar judgements and, lastly, whether typically developing and dRAD children differ in the way they appraise faces in making these judgements.

Importantly, atypical social judgements of faces in children with indiscriminate friendliness could originate from an inadequate strategy in facial feature sampling during social judgements (i.e., gaze avoidance to the eye region). Therefore, eye-movement recording is the method of choice to isolate the facial information sampled by the dRAD population compared to typically developing controls. Mapping eye movement fixation in children with dRAD could thus provide invaluable insights into the mechanisms relating to their potential atypical social judgements of faces.

2. Materials and methods

This study was carried out at the Department of Psychology, University of Glasgow between August 2010 and February 2012. There were 20 participants aged between 6 and 16 years: 10 children and adolescents with symptoms of reactive attachment disorder (RAD) and 10 typically developing controls group-matched for age and gender. The study was approved by the Ethics Committee of the Department of Psychology, University of Glasgow.

For participant characteristics, see Table 1.

2.1. Clinical group

All clinical children were recruited from a pool of participants from a previous research study regarding neurodevelopmental difficulties in maltreated children with indiscriminate friendliness (Kocovska et al., 2012). All participating children had experienced severe maltreatment in the early years, prior to being adopted (age of adoption range 16 months to 7 years), including emotional and/or physical neglect and/or physical abuse often in the context of parental mental illness and/or drug and alcohol problems. In addition, all participating children had indiscriminate friendliness as measured by standardised instruments (for detail regarding the

Table 1
Participant characteristics.

	Controls	Clinical
Age (Mean, SD)	9.62 (1.41)	9.80 (2.74)
Gender	50% Female	50% Female
Mean (SD) SDQ total difficulties score	4.10 (3.93)	19.50 (6.26)
Mean (SD) RPQ total score	1.0 (2.83)	6.62 (5.26)
History of abuse and/or neglect	0%	100%

sampling, please see (Kocovska et al., 2012) and had cognitive functioning in the normal range.

2.2. Controls

7 controls were recruited from the same sample as the clinical children and an additional 3 controls were recruited through outreach.

All cases and controls were screened using the strengths and difficulties questionnaire (SDQ), that explores child and adolescent psychopathology and the relationship problems questionnaire (RPQ) that explores reactive attachment disorder symptoms (see Table 1).

Fully informed parental consent was obtained before each child participated and children were also asked to give verbal assent. Adolescents (aged 12 and over) were asked to give written consent before the start of the study. Participants were paid £20 to cover travel expenses and received a small token of thanks for their participation in the study at the end of the experiment.

2.3. Facial stimuli

Stimuli were obtained from the KDEF (Lundqvist and Litton, 1998) databases and consisted, for each task (attractiveness and trustworthiness judgment), of 18 Western Caucasian identities containing equal numbers of males and females. Only neutral expressions were used. For each task, the 18 identities were chosen, from an on-going study with adults (Lao et al., 2010), in order to form contrasted groups of low, medium and high attractiveness/trustworthiness. Thus, the 1st faces of the stimuli lists for both tasks were corresponding not because originating from the same identity but because they have been judged as being the most attractive and the most trustworthy according to the adult participants. We used those two highly correlated social judgements to further verify the normal evaluation of faces.

The individual face images were 382×390 pixel in size, subtending 15.6° of visual angle vertically and 15.3° of visual angle horizontally, which represents the size of a real face (approximately 19 cm in height). Faces from the original databases were aligned by the authors on the eye and mouth positions; the images were rescaled to match those facial features position and normalized for luminance. Images were viewed at a distance of 70 cm, reflecting a natural distance during human interaction (Hall, 1990). All images were cropped around the face to remove clothing and were devoid of distinctive features (scarf, jewelry, facial hair etc.).

For each trial, 2 faces were presented simultaneously on the screen, both centered vertically and each centered horizontally on the left or right half-screen. All the possible pairs were generated (combinations without repetition) leading to a total of 153 pairs for each task. The pairs order was randomized. The stimuli were presented on a 800×600 pixel grey background displayed on a Dell P1130 21″ CRT monitor with a refresh rate of 170 Hz.

2.4. Apparatus

Eye movements were recorded at a sampling rate of 1000 Hz with the SR Research Desktop-Mount EyeLink 2 K eyetracker (with a chin/forehead rest), which has an average gaze position error of about 0.25°, a spatial resolution of 0.01° and a linear output over the range of the monitor used. Only the dominant eye was tracked, although viewing was binocular. The experiment was implemented in Matlab (R2009b, The MathWorks, Natick, MA), using the Psychophysics (PTB-3) and EyeLink Toolbox extensions (Brainard, 1997; Cornelissen and Peters, 2002). Calibrations of eye fixations were conducted at the beginning of the experiment using a nine-point fixation procedure as implemented in the EyeLink API (see EyeLink Manual) and using Matlab software. Calibrations were then validated with the EyeLink software and repeated when necessary until the optimal calibration criterion was reached. At the beginning of each trial, participants were instructed to fixate a dot at the center of the screen to perform a drift correction. If the drift correction was more than 1°, a new calibration was launched to insure an optimal recording quality.

2.5. Procedure

All participants had normal or corrected vision and were performing the two experimental tasks successively: trustworthiness and attractiveness judgments. The task order was counterbalanced across participants. At the beginning of each task, the participants were informed that they would be presented with a series of face pairs on the screen and that they will have to indicate via button press which face they thought was the most attractive/trustworthy. They were also informed that there was no correct answer and that only their opinion was important. They were advised to go with their first choice without pondering too much on the task. The duration of testing ranged from 30 to 50 min. Each trial started with the presentation of a central fixation cross allowing for calibration check. When the participant was fixating the central cross, a face pair was presented until response. The participants were responding on a keyboard with their left (right) hand index if they thought that the face on the left (right) on the screen was the most attractive/trustworthy. Each trial was subsequently followed by a 2 s delay and the next trial was starting with the central fixation cross. Trustworthiness and attractiveness judgments were collected and analyzed for the purpose of the present experiment. Response times were not taken into account as the children were not instructed to answer fast.

2.6. Data analyses

The behavioral responses were coded in a dichotomous way for each face pair and each participant (1 for the face judged as the most attractive/trustworthy, 0 for the other face). The group results were then summarized as the proportion of participants in a given group judging one of the identities in the face pair more attractive/trustworthy than the other one. We then compared the global judgment agreement between participants between groups and tasks. If all the participants in a group converge to stereotypical attractive/trustworthy faces then the proportion of choosing a face rather than the other in the face pairs should be far from chance level (0.5). We thus performed a 2 (participants group: clinical/control) × 2 (task: attractiveness/trustworthiness) ANOVA on an agreement index defined as $\sqrt{(\text{prob}_{ij} - 0.5)^2}/0.5$ (normalized distance to chance) and ranging, for each face pair, from 0 for absence of agreement to 1 for a perfect agreement.

We also correlated the groups' choice probability matrices between the two tasks for each group of participants. We then computed within-subjects correlation analyses in order to investigate whether the attractiveness and trustworthiness judgments were related *at an individual level*. For each participant we computed a first within-subject Pearson's correlation between the profile of responses for the attractiveness and the trustworthiness tasks. Since correlation coefficients are not additive, they must be *z*-normalized (Chung et al., 2005) before performing statistical analyses. We thus normalized the obtained correlation coefficients by using Fisher's transform $Z = 0.5 \times \log_e |1 + r/1 - r|$ and then preformed a two-tailed *t*-test between groups.

Saccades and fixations were determined using a custom algorithm using the same filter parameters as the EyeLink software (saccade velocity threshold = 30°/s; saccade acceleration threshold = 4000°/s^2) and merging fixations close spatially and temporally (< 20 ms, < 0.3°). Fixation distribution maps were extracted individually for each observer. The statistical fixation maps were computed with the *i*Map toolbox, version 3 (Caldara and Miellet, 2011). iMap3 uses pixelwise *t*-values and bootstrapped TFCE transformed scores to correct for multiple comparisons (TFCE: threshold-free cluster-enhancement; Pernet et al., 2011; Smith and Nichols, 2009).

3. Results

Fig. 1 shows the pairwise probability of choice matrices for both groups of participants and both tasks. This representation suggests, for both tasks, more inter-participant agreement for the controls than for the clinical children (darker colors, dark red or dark blue corresponding to more extreme probabilities). Fig. 1 also shows, for both tasks, more structure in the judgments for the controls than for the clinical children. For instance, number 8 has been consistently judged more attractive than any other face by the control children and, face 17 consistently less than any other face by controls.

The 2 (participants group: clinical/control) × 2(task: attractiveness/trustworthiness) ANOVA on the agreement index revealed a main effect of the group ($F(1, 304) = 126.75$, $p < .0001$, $p\eta^2 = .29$). This result confirms a stronger agreement between the control participants (average agreement across the face pairs: 0.54 and 0.49 for the attractiveness and trustworthiness task) than between the clinical participants (0.29 and 0.27). No other effect was significant. The choice probability matrices were strongly correlated between the attractiveness and trustworthiness tasks for the control participants ($r = 0.66$, $p < .0001$) but not the clinical participants ($r = 0.11$, $p = .19$). In order to confirm the previous result *at an individual level* (that the same control participants chose a given face in both tasks), we performed within-subjects correlations. This analysis confirmed a stronger correlation between the two tasks for the control than for the clinical children (average normalized *r*: 0.4 and 0.09 respectively, $t(18) = 4.06$, $p < .001$). The correlation between the attractiveness and the trustworthiness task was significantly different from 0 for the control children ($t(9) = 6.64$, $p < .0001$) but not for the clinical children.

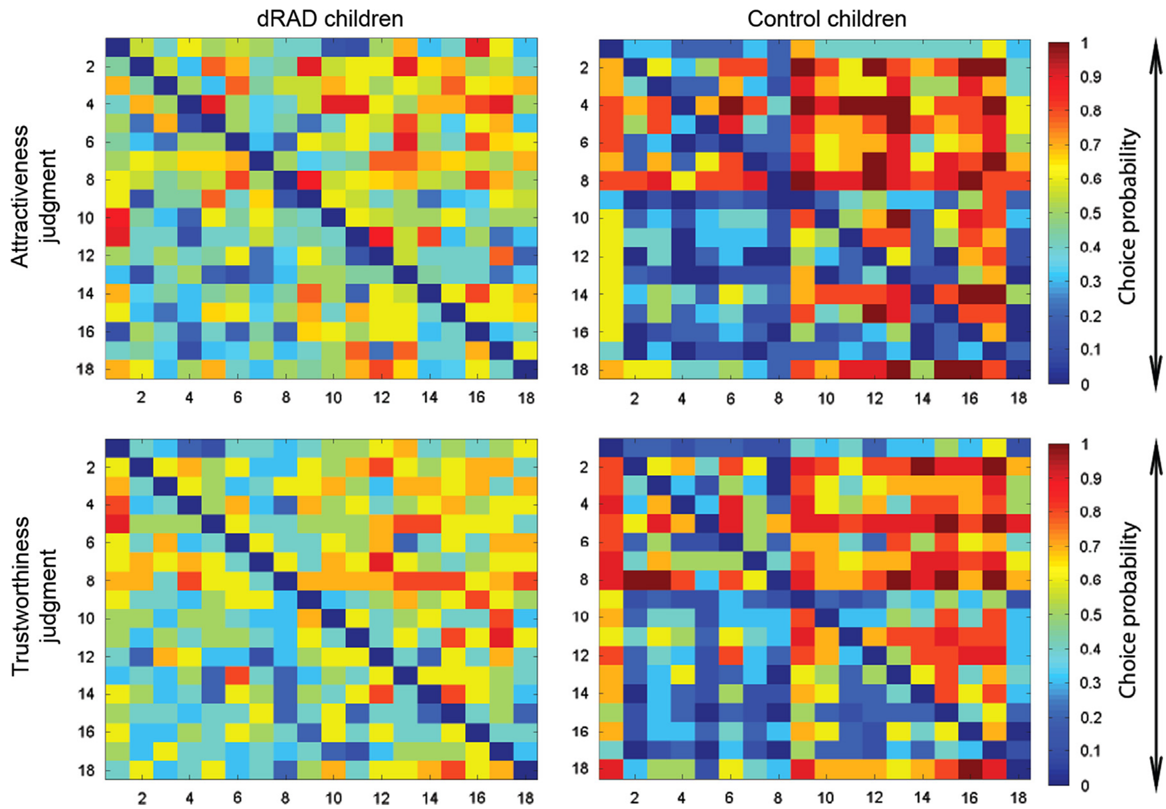

Fig. 1. Probability of choice matrices for both children groups (dRAD and controls) and both tasks (attractiveness and trustworthiness judgment). Each line of the matrices shows the probability of choosing a given face over all the remaining faces. The hot colors (yellow to red) indicate that the face corresponding to line number was chosen more (> 0.5) than the face corresponding to the column number. The cold colors (light blue to dark blue) indicate that it has been chosen less (< 0.5). The diagonal does not contain any value, as faces were never compared with themselves. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 2 shows fixation maps and the regions significantly fixated above chance level according to *i*Map (version 3) for control and clinical children during both judgment tasks. The fixation maps show that both dRAD and typically developed children use the same sampling strategies to extract facial information during social judgment.

Note that the central fixation cluster is due to the first fixation of each trial. The presentation of the faces pair was preceded by a central fixation cross allowing for calibration check. Hence, when the recording started, as faces were presented, the participants' eyes were still fixating the center of the screen until the first saccade towards one the faces.

4. Discussion

Our findings show that, like adults, typically developing children show clear preferences and high inter-observer agreement while evaluating unfamiliar faces on both attractiveness and trustworthiness. In contrast, the dRAD group of maltreated children with indiscriminate friendliness showed less clear preferences on these tasks (lower inter-participant agreement and less structure in the pairwise choice matrices). Moreover, only the typically developing, and not the children with dRAD symptoms, show the expected strong correlation (at group and individual levels) in their trustworthiness and attractiveness judgments. This link between attractiveness and trustworthiness judgments has been clearly established in adults in previous studies (for instance Oosterhof and Todorov, 2008; Willis and Todorov, 2006). Hence, the control children display a pattern of results consistent with what is observed in adults and consistent with the findings of Antonakis and Dalgas (2009), which is not the case for the dRAD children. Finally, dRAD children use the same facial information sampling strategy as control children, with both groups of children looking preferentially in the eyes region, a fixation pattern that is not modulated by the task (trustworthiness vs. attractiveness judgment). Critically, this observation rules out the possibility that the impairment in making social judgments from faces in dRAD population is arising from an inappropriate fixation towards diagnostic facial features. It should be noted that these findings apply to maltreated children who have the core symptom of RAD, namely indiscriminate friendliness and may not apply to all maltreated children.

Considering that children with dRAD sample faces in a similar way to typically developing children, their atypical social judgments may result from a specific problem with *processing* the visual information available for social judgment. When designing, analysing and interpreting eye-movement studies it is crucial to keep in mind that eye movement recordings in natural viewing conditions do not provide unequivocal evidence regarding the measure of the visual information being used by observers. As a matter of fact, despite being tight, the coupling between fixated and processed information is not perfect (concepts of overt vs. covert attention, Posner, 1980). Hence, critical visual information is extracted from extrafoveal vision (see Caldara et al., 2010; Miellet et al., 2012). Our results reveal that the scanning strategy adopted by RAD and control children is similar. However, they do not necessarily imply that both populations use the same information in order to perform the task at hand. Future studies, using gaze-contingent techniques, would allow more fine-grained investigation of the information use for social judgment in RAD children. Indeed, gaze-contingent techniques can overcome limitations

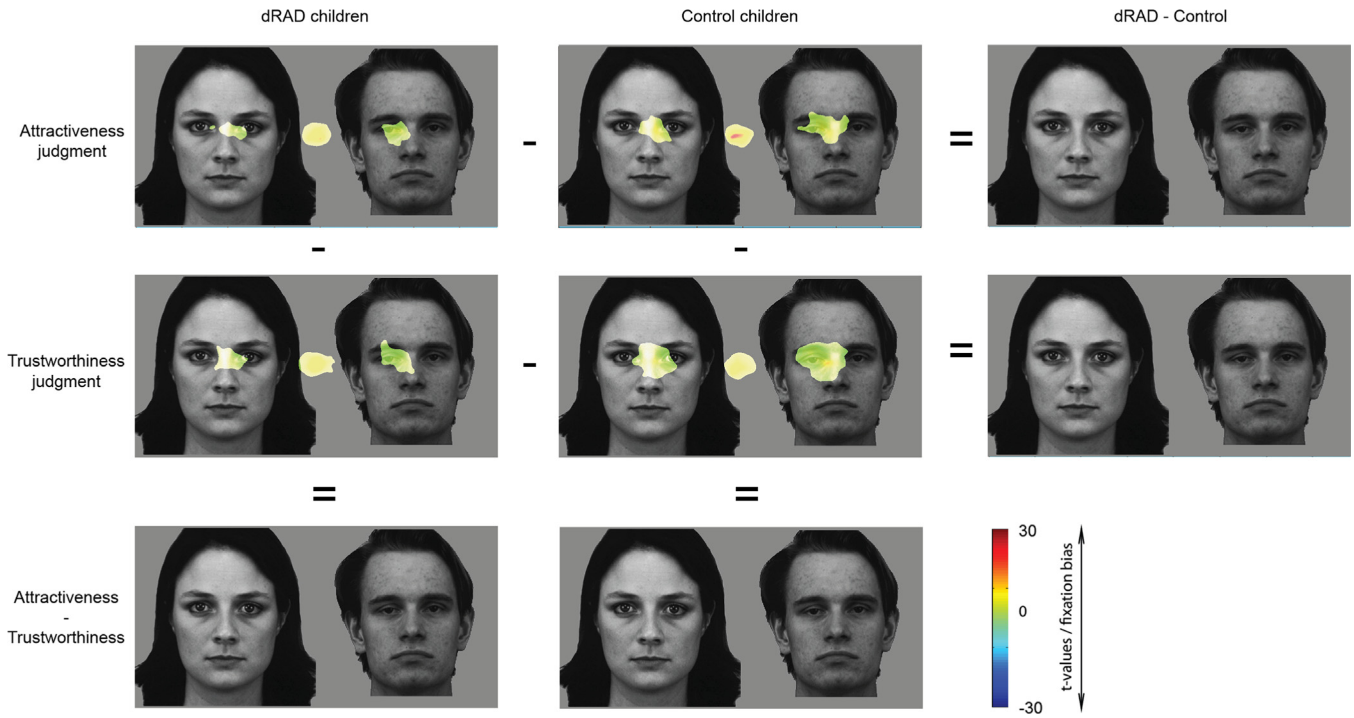

Fig. 2. Fixation maps based on the fixation durations for each task and each children group. Subtracting the fixation maps for the control children from the fixation maps for the dRAD children resulted in the group difference maps for each task (third column). Similarly, subtracting the fixation maps for the trustworthiness task from the fixation maps for the attractiveness task resulted in the task difference maps for each group (third row). On the fixation maps, the colored clusters show areas that are fixated significantly longer than the average fixation duration. No significant areas are visible on the difference maps.

inherent in simple eye-movement recording. By precise online control of the information projected in different parts of the visual field, the gaze-contingent techniques permit us to disentangle what is fixated and what is processed. Therefore, the gaze-contingent technique is a powerful method to control for the visual information feeding the visual system and to isolate information use (Miellet et al., 2011, 2013).

Regardless of the inherent limitations of natural eye movement recordings, the present data provide an interesting contrast to children with ASD who show atypical gaze pattern towards social relevant stimuli and particularly during face exploration. Despite being an on-going debate, the fixation bias in ASD has been replicated in a substantial number of studies (Noris et al., 2012; Pierce et al., 2011; Riby and Hancock, 2009; Rice et al., 2012; Chawarska and Shic, 2009; Pelphrey et al., 2002; Dalton et al., 2005; Jones et al., 2008; Kliemann et al., 2010; Klin and Jones, 2008; Klin et al., 2002). Thus, it seems that, in contrast with children with ASD, the difficulties experienced by children with RAD are not linked to sampling of facial features but to a problem with specific processing of the very same visual information that is available to typically developed children. Various authors have described reactive attachment disorder as a social impairment, rather than as a disorder of attachment (Green and Goldwyn, 2002; Minnis et al., 2006) and these results support this view: despite its environmental aetiology, it appears that neurological processes may have been set in train by the early environmental insult that are perpetuated through development.

Our findings are somewhat limited by our modest sample size, hence interpretations and generalizations of the present findings have to be made with caution given the potential heterogeneity of both causes and symptomatology in RAD. Although our main analyses were adequately powered it would be interesting in future research to recruit large enough samples to explore, for example, whether there are within group differences according to IQ or symptom severity.

Our findings have important implications for the way we understand indiscriminate friendliness in maltreated children. If children with dRAD are less effective than controls at using available information from faces, resulting in similar problems to those experienced by children with ASD, although through different mechanisms, then treatment strategies such as those that are effective in ASD may be worth trialing in this group. For example, the “Lets Face It” program has been useful in working with children with ASD in both understanding the nature of the deficits and in effecting actual improvement in facial emotion recognition (Tanaka et al., 2013). Using similar programs with indiscriminately friendly children may help us better understand the nature of their problems in this domain and improve their functioning.

This study is a first step in teasing out the nature of the deficits in face processing in indiscriminately friendly children and there are various avenues for future research. fMRI studies will be important in identifying the brain regions associated with these difficulties and may further deepen our understanding of the nature of the deficits. It will also be important to conduct detailed face processing studies comparing indiscriminately friendly children to maltreated children who do not suffer from indiscriminate friendliness, before we can be confident that the face processing deficits and clinical phenomenology are linked. Comparisons with children suffering from other neurodevelopmental disorders such as ASD and William's syndrome may also help determine whether or not there is a signature “indiscriminate friendliness” syndrome as regards face processing deficits or whether these children are in fact suffering from similar difficulties to other groups of children.

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