Received: 18 December 2023 | Revised: 8 April 2024 | Accepted: 28 April 2024

DOI: 10.1002/erv.3103

BRIEF REPORT

WILEY

Superior facial emotion recognition in adolescents with anorexia nervosa – A replication study

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Handling Editor: Beate Herpertz-Dahlmann

Funding information
Förderprogramm für Forschung und Lehre (FöFoLe) of the Medical Faculty of the LMU Munich, Grant/Award Number: Reg.-No. 997

Abstract

Objective: Anorexia nervosa (AN) has been associated with alterations in the processing of socio-emotional information, including impairments in the recognition of emotions in other people's faces. However, adolescents with AN might not show the impairments found in adult patients. The present study investigated facial emotion recognition in adolescents with AN, aiming to replicate our previous results of superior emotion recognition abilities in adolescents with AN compared to adolescents without mental disorders.

Method: Adolescent girls (12–18 years) with AN (n = 33) were compared to girls without mental disorders (n = 41). Participants completed one task requiring identification of emotions (happy, sad, afraid, angry, neutral) in faces and one control task.

Results: As expected, adolescents with AN showed superior emotion recognition, with higher accuracy rates specifically for afraid faces.

Conclusion: This is the first study replicating previous results on basic emotion recognition in adolescents with AN using (almost) the same methodology. The results suggest that, in contrast to adults, adolescents with AN do not show impairments in facial emotion recognition. The impairments may arise in the longer course of the illness, however, longitudinal studies are necessary to confirm this assumption.

KEYWORDS
adolescence, anorexia nervosa, eating disorders, emotion recognition, emotional faces

Highlights

- Adolescent girls with anorexia nervosa (AN) did not show impairments in facial emotion recognition compared to adolescents girls with no mental disorders

The present study was approved by the ethics committee of the Medical Faculty of the LMU Munich (Project-No. 18-228). Prior to participation, written informed consent was obtained from all participants (and their parents/legal guardians for participants under 18 years of age) after a comprehensive explanation of the study procedures.

- On the contrary, adolescent with AN showed superior emotion recognition specifically for afraid faces (and a trend for sad faces)
- The results replicate those of a previous study and suggest that emotion recognition impairments may arise with prolonged illness duration

1 | INTRODUCTION

Anorexia nervosa (AN) has been associated with difficulties and alterations in socio-emotional functioning (see e.g., Caglar-Nazali et al., 2014; Tauro et al., 2022), which are proposed to play an important role in the development and maintenance of the disorder (Treasure & Cardi, 2017; Treasure et al., 2012). One important socio-emotional ability that has been investigated in AN is the recognition of emotions in other people's faces, which is key to successful social interaction (e.g., Bourke et al., 2010). The majority of studies in adult samples has found impairments in facial emotion recognition in individuals with AN (see Caglar-Nazali et al., 2014; Oldershaw et al., 2011), however, there are also studies that did not find differences between women with AN and women without mental disorders (e.g., Kerr-Gaffney et al., 2020; Kucharska et al., 2016).

Fewer studies have examined emotion recognition in adolescents with AN. This seems of particular importance, not only because adolescence is the most common time for the onset of AN (Solmi et al., 2022), but also because the ability to recognise facially expressed emotions is still developing (e.g., Herba & Phillips, 2004) while at the same time social demands are increasing (Happé & Frith, 2014) in this developmental period. Therefore, difficulties in socio-emotional functioning in adolescence could have particularly detrimental consequences. The few studies on facial emotion recognition in adolescents with AN indicate that adolescents might not show the same impairments as adults: Most studies investigating basic emotion recognition found either no differences between adolescents with AN and adolescents without mental disorders (Hatch et al., 2010) or found adolescents with AN to perform slightly better (i.e., higher accuracy: Sfärlea et al., 2018; or faster reaction times: Lulé et al., 2014), while only one study found adolescents with AN to show reduced emotion recognition abilities in comparison to adolescents without mental disorders (Zonnevylle-Bender et al., 2004a). In our own study on basic emotion recognition, we found superior accuracy in adolescents with AN compared to adolescents without mental disorders, specifically for the recognition of afraid facial expressions (Sfärlea et al., 2018). Studies investigating more complex emotion recognition via the Reading the Mind in the Eyes test (Baron-Cohen et al., 2001) corroborate the notion that adolescents with AN show no impairments: Most studies reported no differences between adolescents with and without AN (e.g., Nalbant et al., 2019; Rothschild-Yakar et al., 2019; but see also Zegarra-Valdivia & Chino-Vilca, 2018). However, especially with respect to basic emotion recognition, studies in adolescents with AN are scarce and their results are heterogeneous, perhaps due to different tasks and emotions being investigated. Studies aiming to replicate previous results on basic emotion recognition using the same methodology are lacking to date.

Therefore, the present study was designed to replicate our previous findings regarding basic emotion recognition in adolescents with AN compared to adolescents with no mental disorders (Sfärlea et al., 2018). As in the previous study, we applied an emotion discrimination task and a gender discrimination task (as control condition) with faces showing five emotions (happy, sad, afraid, angry, neutral) as stimuli. We expected to replicate the previous results, that is, to find adolescents with AN to perform superior to adolescents without mental disorders, with higher accuracy rates specifically for afraid faces.

2 | METHODS

The present data on facial emotion recognition were collected within a broader project investigating the neurophysiological mechanisms underlying processing of socio-emotional stimuli in adolescents with AN Sfärlea et al. (in preparation).

2.1 | Participants

Seventy-four[1] adolescent girls aged 12–18 years were included in the study. The $n = 33$ adolescents with AN were recruited at the Department of Child and Adolescent Psychiatry, Psychosomatics and Psychotherapy of the LMU University Hospital in Munich. The $n = 41$ girls with no mental disorders (healthy control (HC) group) were recruited via previous studies and mailings to randomly-selected families with daughters in the corresponding age range provided by the local registry office. The study was approved by the ethics committee of the Medical Faculty of the LMU Munich (Project-No. 18-228). Prior to participation, written informed consent was obtained from all participants (and their parents/legal guardians for participants under 18 years of age) after a comprehensive explanation of the study procedures. Participants received a reimbursement of €50.

In all participants, psychiatric diagnoses were assessed using a standardized, semi-structured interview (Kinder-DIPS; Margraf et al., 2017; Schneider et al., 2017) that was conducted and evaluated by trained interviewers and showed excellent interrater-reliability (100% accordance rate for current diagnosis of AN, determined for 25% of the sample). Depressive symptoms were assessed with the Beck Depression Inventory-II (BDI-II; Hautzinger et al., 2009), while eating disorder symptoms were assessed with the Eating Disorder Inventory-2 (EDI-2; Thiel et al., 1997), both with Cronbach's αs $\geq$ 0.97 in the current sample. Exclusion criteria for all participants were IQ < 85 (assessed with the CFT 20-R; Weiß, 2006), (non-corrected) visual impairments, current neurological, pervasive developmental, psychotic, or bipolar disorders, and substance abuse. Participants who met DSM-5 (American Psychiatric Association, 2013) criteria for AN and had a body mass index (BMI) ≤25th age-corrected percentile[2] (Kromeyer-Hauschild et al., 2001) were included in the AN group. The AN group consisted of 28 participants with restricting type AN and 5 participants with binge/purge type AN with a median illness duration of 17 months (range 1-120). 45% of the adolescents in this group met criteria for at least one comorbid condition, mostly major depression (n = 13) and anxiety disorders (n = 8); n = 5 were taking psychotropic medication. Participants not meeting criteria for any current or past mental disorders were included in the HC group. See Table 1 for participant characteristics.

2.2 | Experimental tasks

2.2.1 | Stimuli

Stimuli consisted of 100 greyscale photographs of faces (50 male, 50 female) from the Karolinska Directed Emotional Faces database (Lundquist et al., 1998) displaying full intensity emotional expressions (happy, sad, afraid, angry, neutral). To focus attention on the emotional expression, pictures were edited to show only the facial area (e.g., Rellecke et al., 2012). Stimuli had the size of approximately 10.5 × 14.5 cm and were presented at the centre of the screen on black background.

2.2.2 | Task procedure

Participants were seated in front of a 17.5-in. computer screen at a viewing distance of 70 cm. The experiment was presented using E-Prime 2.0 software (Psychology Software Tools, 2013). Tasks were presented block-wise in random order, separated by short breaks. At the beginning of each task, participants received instructions and practice trials. Participants were instructed to respond as quickly and as accurately as possible to the stimulus presented by pressing a button on a response pad. In the emotion discrimination task they had to indicate which emotion (happy, sad, afraid, angry, or neutral) the face expressed. In the gender discrimination task they had to decide if the person depicted was male or female.

A trial started with a fixation cross presented for 800–1000 ms. Then the face was presented for 1500 ms, followed by a blank screen (1000 ms; see Figure S1). Answers were recorded during stimulus presentation and blank screen. Tasks comprised 40 trials of each emotion category, resulting in a total of 200 trials per task. Trial order within each task was random.

2.3 | Data analysis

Data were analysed with SPSS. Percentage of correct answers and mean reaction time for correct answers (RT) for each emotion served as outcome measures. Reliability

TABLE 1 Demographic and clinical characteristics of the study sample.

	AN n = 33 *M (SD)*	**HC** n = 41 *M (SD)*	**Group comparisons**	
Age	15.60 (1.65)	15.45 (1.56)	$t < 1$	n.s.
IQ	106.55 (12.34)	106.32 (12.36)	$t < 1$	n.s.
BMI	15.60 (1.57)	20.44 (2.27)	$t_{70.48} = 10.81$	$p < 0.001$
Age-corrected BMI-percentile	3.64 (5.03)	49.68 (25.08)	$t_{43.96} = 11.47$	$p < 0.001$
BMI-SDS	−2.49 (1.20)	−0.03 (0.76)	$t_{52.02} = 10.25$	$p < 0.001$
Eating disorder symptoms (EDI-2)	308.50 (62.15)	183.36 (39.62)	$t_{50.54} = 9.86$	$p < 0.001$
Depression symptoms (BDI-II)	24.61 (13.69)	2.59 (3.24)	$t_{34.89} = 9.04$	$p < 0.001$

Abbreviations: AN, anorexia nervosa; BDI-II, Beck Depression Inventory-II; BMI, body mass index; BMI-SDS, body mass index standard deviation score; EDI-2, Eating Disorder Inventory 2; HC, healthy control; IQ, intelligence quotient.

was questionable to acceptable for percentage of correct answers (0.61 ≤ Cronbachs α ≤ 0.76) and good to excellent for RTs (0.82 ≤ Cronbachs α ≤ 0.98). Mixed analyses of variance (ANOVAs) with within-subject factors TASK (2: emotion discrimination, gender discrimination) and EMOTION (5: happy, sad, afraid, angry, neutral) and the between-subjects factor GROUP (2: AN, HC) were performed. As the main focus of the study was to compare adolescents with AN to controls, only significant effects involving the factor GROUP were followed up using post-hoc ANOVAs and *t*-tests. Degrees of freedom were adjusted via the Greenhouse-Geisser correction and the significance level of $p = 0.05$ was adjusted using the Bonferroni-Holm procedure (Holm, 1979) when multiple post-hoc comparisons were performed.

3 | RESULTS

Descriptive results are presented in Table S1.

3.1 | Percentage of correct answers

The TASK × EMOTION × GROUP ANOVA on percentage of correct answers revealed significant main effects of TASK ($F_{1,72} = 23.05$, $p < 0.001$, $\eta_p^2 = 0.243$) and EMOTION ($F_{3.60,259.32} = 87.04$, $p < 0.001$, $\eta_p^2 = 0.547$). In addition, a TASK × GROUP interaction ($F_{1,72} = 7.55$, $p = 0.008$, $\eta_p^2 = 0.095$) as well as a TASK × EMOTION interaction ($F_{3.53,254.47} = 42.12$, $p < 0.001$, $\eta_p^2 = 0.369$) emerged and were further qualified by a TASK × EMOTION × GROUP interaction ($F_{3.53,254.47} = 3.08$, $p = 0.021$, $\eta_p^2 = 0.041$). The main effect of GROUP and the EMOTION × GROUP interaction were non-significant (*F*s ≤ 1.50, *p*s > 0.1). To follow up the 3-way interaction, EMOTION × GROUP ANOVAs were calculated separately for each task:

For the emotion discrimination task the follow-up ANOVA yielded significant main effects of EMOTION ($F_{3.33,239.86} = 72.19$, $p < 0.001$, $\eta_p^2 = 0.501$) and GROUP ($F_{1,72} = 4.59$, $p = 0.036$, $\eta_p^2 = 0.060$) as well as a significant EMOTION × GROUP interaction ($F_{3.33,239.86} = 2.79$, $p = 0.036$, $\eta_p^2 = 0.037$). Subsequent *t*-tests comparing AN and HC groups' percentage of correct answers separately for each emotion found a significant difference for afraid faces ($t_{67.97} = 2.66$, $p = 0.010$, $d = 0.59$) and a trend for sad faces ($t_{72} = 2.20$, $p = 0.031$, $d = 0.51$; not significant after correction for multiple testing) with the AN group performing better than the HC group (see Figure 1). Groups did not differ for neutral, happy, and angry faces (*t*s ≤ 1.54, *p*s > 0.1).

The follow-up ANOVA for the gender discrimination task yielded a significant main effect of EMOTION ($F_{3.17,228.26} = 40.98$, $p < 0.001$, $\eta_p^2 = 0.363$) but no main effect or interaction involving GROUP (*F*s < 1).

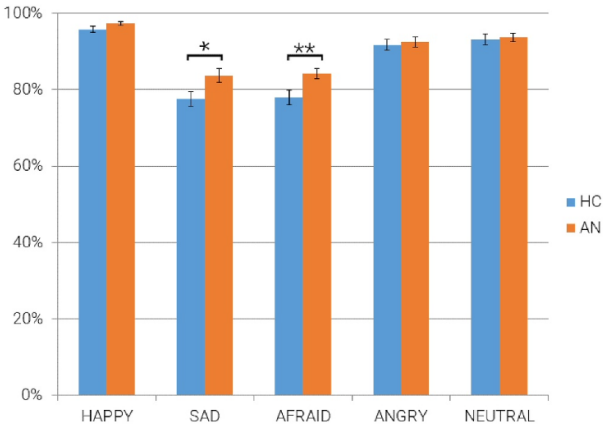

FIGURE 1 Mean percentage of correct answers for each emotion in the emotion discrimination task. Error bars represent standard errors. *$p < 0.05$, but not significant after correction for multiple testing; **$p < 0.01$, significant after correction for multiple testing. [Colour figure can be viewed at wileyonlinelibrary.com]

3.2 | RTs

The TASK × EMOTION × GROUP ANOVA on RTs yielded significant main effects of TASK ($F_{1,72} = 405.55$, $p < 0.001$, $\eta_p^2 = 0.849$) and EMOTION ($F_{3.53,254.18} = 131.98$, $p < 0.001$, $\eta_p^2 = 0.647$) that were qualified by a significant TASK × EMOTION interaction ($F_{3.20,230.38} = 105.87$, $p < 0.001$, $\eta_p^2 = 0.595$). No main effect or interactions involving GROUP were found (*F*s < 1).

3.3 | Additional analyses

In addition to accuracy rates and reaction times, we also analysed misclassification errors (as in our previous study; Sfärlea et al., 2018) in order to examine whether groups differed in tendencies to misclassify faces as showing specific emotions. The results of these analyses are presented in the Supplement.

Furthermore, exploratory analyses were performed to examine if recognition performance was related to clinical characteristics. Pearson's correlations were computed between percentage of correct answers for afraid and sad faces and EDI-2, BDI-II, and BMI-SDS scores (within both groups) as well as illness duration (within the AN group). In the AN group, a negative trend between illness duration and recognition performance for afraid faces emerged ($r = -0.32$, $p = 0.069$) while in the HC group, a positive correlation between depression symptoms and

recognition performance for sad faces emerged ($r = 0.36$; $p = 0.023$). However, none of these correlations was significant after correcting for multiple comparisons.

4 | DISCUSSION

The present study examined facial emotion recognition in adolescents with AN compared to adolescents with no mental disorders, seeking to replicate the findings of our previous study (Sfärlea et al., 2018). As expected, we found adolescents with AN to perform superior to adolescents without mental disorders, with higher accuracy rates specifically for afraid faces (and a trend for sad faces). No group differences emerged in the control condition, indicating that groups did not differ regarding processing of faces per se or general performance in reaction time tasks.

This is the first study replicating previous results on basic emotion recognition in adolescents with AN using (almost)[3] the same methodology. We found the same pattern of results as in our previous study (Sfärlea et al., 2018) in an independent sample of adolescents with and without AN, allowing us to interpret our results with more confidence. It seems that adolescents with AN do not show the same impairments in facial emotion recognition as adults with AN (e.g., Caglar-Nazali et al., 2014). Compared to adults, adolescents with AN are at a relatively early stage of the disorder. Thus, one could assume that impairments in facial emotion recognition may develop with prolonged illness duration, which is also supported by a negative association between illness duration and recognition accuracy for afraid faces in the present sample of adolescents with AN as well as negative correlations between AN illness duration and complex emotion recognition reported in previous studies (e.g., Calvo Sagardoy et al., 2014; Zegarra-Valdivia & Chino-Vilca, 2018; but see also, e.g., Kucharska et al., 2016). However, given the cross-sectional design of the present study and the association being only a trend, the assumption that emotion recognition abilities deteriorate in the course of the illness remains speculative. Associations of facial emotion recognition impairments and illness duration could also result from these impairments being a negative predictor for therapy outcome, that is, for those adolescents with pronounced emotion recognition impairments at an early stage, the disorder might be more likely to take a chronic course. Future studies should disentangle these possibilities by investigating facial emotion recognition in the course of AN, for example, by comparing individuals with short and long illness durations (e.g., adolescents vs. adults[4] or individuals at different stages of AN according to the staging model by Treasure et al., 2015) or with longitudinal studies allowing to investigate if facial emotion recognition abilities indeed deteriorate during the course of the disorder. Thereby, researchers could also shed light on the role of age of onset, that is, investigate whether individuals with an early onset of AN show particularly pronounced emotion recognition impairments later on, as the disorder might interfere with the ongoing development of emotion recognition abilities.

The result of intact emotion recognition abilities in adolescents with AN is also in line with most other studies investigating basic (Hatch et al., 2010) and more complex (e.g., Nalbant et al., 2019; Rothschild-Yakar et al., 2019) emotion recognition in adolescents with AN, which also found no impairments in this population using different experimental tasks. Some studies also reported superior emotion recognition in adolescents with AN (Laghi et al., 2015; Lulé et al., 2014) and offered various explanations like increased sensitivity for other people's emotions (Laghi et al., 2015) or pronounced perfectionism (Lulé et al., 2014). In the present study, perfectionism was also more pronounced in adolescents with AN compared to adolescents with no mental disorders[5] and it is possible that lower perfectionism led to declining motivation in the latter group. However, as perfectionism did not correlate with recognition performance ($rs \leq 0.161$, $ps \geq 0.1$) it is unlikely that it accounts for our results. In our previous study, we argued that adolescents with AN might process faces in a "less emotional" manner, possibly resulting in more cognitive resources being available for categorisation of the stimuli (Sfärlea et al., 2016, 2018). The superior recognition accuracy of the AN group particularly for afraid (and sad) faces might be explained by these emotions being the most difficult to categorise, while ceiling effects might have occurred for the other emotional expressions (correct answer rate >90% for happy, angry, and neutral faces). In a different study, we found a tendency for adolescents with AN to show increased attention to the eye-area of emotional faces (Nuding et al., 2024). Attention to the eye-area has been suggested to be related to facial emotion recognition in individuals with AN (Fujiwara et al., 2017; Kerr-Gaffney et al., 2021), and identification of fear and sadness relies particularly on attention to the eyes (Adolphs et al., 2005; Eisenbarth & Alpers, 2011), so this might offer another explanation for adolescents with AN's superior emotion recognition ability especially regarding afraid (and sad) faces. However, it remains subject to future research to investigate the relationship between facial emotion recognition and attention to the eyes to understand their interplay.

In addition to the mentioned limitations, the interpretation of our results is limited by the choice of stimuli, which consisted of standardized, static pictures of full intensity emotional expressions. These have rather low ecological validity, as dynamic and more subtle emotional expressions are usually encountered in real life (e.g., Dapelo et al., 2016). The use of full intensity expressions may have led to a ceiling effect for some of the emotions, thereby masking differences in the identification of those. Future studies should include more ecologically valid stimuli, for example, stimuli that vary in emotional intensity (e.g., Dapelo et al., 2016), stimuli that allow assessment of complex emotion recognition[6] (e.g., Kerr-Gaffney et al., 2020), or dynamic stimuli (film clips, e.g., Oldershaw et al., 2010). Furthermore, it should be noted that the sample of the present study showed very similar participant characteristics as the sample of our previous study, which may explain why we succeeded in exactly replicating the pattern of results but may also limit the generalisability of our results. The HC group might not be representative of the general population of adolescent girls as youth with a history of all mental disorders were excluded. Future studies should include more diverse samples to assess if the pattern of results is transferrable to those and also larger samples that would allow to detect differences in the recognition of sadness not only on the trend level.

4.1 | Clinical implications

Adolescents and adults with AN differing in socio-emotional skills like facial emotion recognition could explain why trainings aiming to improve socio-emotional functioning (as for example Cognitive Remediation and Emotion Skills Training; Tchanturia et al., 2014) might be more promising in adults (Tchanturia et al., 2014, 2015) than in adolescents (Giombini et al., 2021) with AN. Characterising the different stages of AN (Treasure et al., 2015) with respect to socio-emotional functioning is pivotal in order to advance therapeutic options and be able to tailor them according to the specific needs of the individuals at that specific stage of the disorder.

AUTHORS' CONTRIBUTIONS

Anca Sfärlea designed the study and obtained funding for the study. She analysed the data and wrote the manuscript. Christina Buhl and Linda Lukas collected the data. Gerd Schulte-Körne supervised the study. All authors contributed to writing the manuscript and have read and approved the final manuscript.

ACKNOWLEDGEMENTS

We thank Petra Wagenbüchler and ANAD e.V. for their help with participant recruitment, Lea Zwilling for her help with data collection, and Amanda Sommerhoff for re-rating the diagnostic interviews.

Open access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no competing interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

The present study was part of a project funded by the "Förderprogramm für Forschung und Lehre" (FöFoLe, Reg.-No. 997) of the Medical Faculty of the LMU Munich. The funder played no role in study design, data collection, analysis and interpretation of the data, or preparation of the manuscript.

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ENDNOTES

[1] Sample size was based on a-priori power analyses for differences in neurophysiological processing of socio-emotional stimuli in adolescents with AN versus adolescents with no mental disorders, as smaller effects were expected for neurophysiological than for behavioural differences. These analyses resulted in a target sample size of $n = 35$ per group.

[2] The 25th percentile was defined as inclusion criterion as this allowed to include participants who showed pronounced AN symptoms such as weight phobia and body image disturbance but were not yet or not anymore underweight, that is, participants with atypical AN who had lost a significant amount of weight through unhealthy behaviours but were not underweight (yet) and partly weight-restored participants who had been underweight but had already gained some weight in the inpatient setting. Two participants in the AN group had a BMI above the 10^{th} percentile; repeating all analyses excluding them yielded the same pattern of results.

[3] As mentioned above, data were collected within a broader project that investigated the neurophysiological correlates of processing socio-emotional stimuli. To be able to compare different stimulus categories, all stimuli were presented in greyscale on black background, which did not correspond to our previous study in which faces were presented in colour on grey background (Sfärlea et al., 2018).

[4] Of note, two studies to date have compared adolescents and adults with AN regarding basic (Zonnevylle-Bender et al., 2004b) and complex (Calvo Sagardoy et al., 2014) emotion recognition. None of them reported differences between adolescents and adults, with one study reporting impairments in both age groups (Zonnevylle-Bender et al., 2004b) and no relationship between emotion recognition accuracy and illness duration and the other reporting no impairments but a correlation between recognition accuracy and illness duration (Calvo Sagardoy et al., 2014). No conclusions can be drawn based on these heterogeneous results and additional, systematic studies are necessary.

[5] Significantly higher scores on the perfectionism subscale of the EDI-2 in the AN group compared to the HC group ($p < 0.001$).

[6] Of note, studies investigating complex emotion recognition in adolescents with AN have reported similar (Bentz et al., 2017) or smaller effects (e.g., Laghi et al., 2015; Rothschild-Yakar et al., 2019).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Sfärlea, A., Buhl, C., Lukas, L., & Schulte-Körne, G. (2024). Superior facial emotion recognition in adolescents with anorexia nervosa – A replication study. *European Eating Disorders Review*, *32*(5), 943–951. https://doi.org/10.1002/erv.3103