The Behavioral and Physiological Effect(s) of Social Defeat among Male Adolescents: A Pilot Study

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Abstract

The aim of the present study was to examine the concept of social defeat in a human sample. Relationships between an ethnic minority position, implicit and explicit self-esteem, heart rate, skin conductance, and social support were examined. In addition, the relationship between self-reported behavioral problems on the one hand, and self-esteem and physiology on the other hand was explored. The sample consisted of 56 male adolescents 12-18 years of age, who were divided, based on self-report behavioral problems into a high and low risk group. The implicit association task and the Rosenberg self-esteem scale were used to measure self-esteem. Measures of heart rate and skin conductance were collected during an affective research paradigm. There were no relationships between an ethnic minority position and any of the behavioral measures. Individuals reporting a significant degree of behavioral problems had lower explicit self-esteem. Average heart rate was found to be related to internalizing behavior in a low-risk group regardless of SES, self-esteem or social support. Social support did diminish the effect of average heart rate on externalizing behavior in the low-risk group. In conclusion, no clear picture of the social defeat concept is revealed by this study, more research is required.

Keywords: social defeat, self-esteem, social support, heart rate, skin conductance

Experiencing an outsider position in society, also called ‘social defeat’ may have large consequences for mental health (Taylor, Gooding, Wood, & Tarrier, 2011). Social defeat reflects the perception of failed struggle related to the loss of status, identity or resources. Depressive-like symptoms such as social withdrawal and submissiveness are found to be associated with this concept of social defeat. In animal studies, social defeat and related severe consequences have been observed. Socially defeated animals show depressive-like symptoms (Björkqvist, 2001) and an altered physiological and behavioral response to stress (Meerlo, Overkamp, & Koolhaas, 1996; Razolli, Carboni, & Arban, 2009). Because studies into the behavioral and physiological consequences of social defeat in humans are scarce (Björkqvist, 2001) the question remains whether humans react similarly to social defeat as animals. The influence of social defeat on human physiology will be investigated by examining the autonomic nervous system reactivity (i.e. heart rate and skin conductance) in response to a specifically designed paradigm in adolescent males.

Animal studies

Social defeat The concept of social defeat finds its origin in animal research and it has been extensively studied with especially rodents. The resident-intruder paradigm is an often used model to provoke social stress in animals (Björkqvist, 2001). In this paradigm a male rodent is put into the home cage of another male rodent. This will incite a fight leading to one of them being beaten up. The (beaten) subordinate animal is considered to experience social stress and to be the socially defeated animal (Björkqvist, 2001). Fighting between rodents on a single occasion is regarded as a model of acute stress, whereas fighting on multiple occasions during consecutive days is regarded as a model of chronic stress (Björkqvist, 2001).

Social defeat and physical and behavioral consequences Rodents experiencing social defeat are found to show reductions in locomotion, decreased motivation and a lack of

interest in rewarding stimuli. In addition, weight loss and altered sleep patterns are observed physiological effects of social defeat (Taylor et al., 2011). In several other kinds of nonhuman species, both single and multiple occasions of social defeat are found to result in changed behavioral, hormonal, physiological, immunological functioning and neurotransmitter responses (Björkqvist, 2001; Koolhaas et al., 1990; Verhoeve, Kelly, Luz, Ghanshani, & Bhatnagar, 2013). The involuntary defeat strategy is proposed as an involuntary subordinate strategy to respond psychobiologically to perceptions of defeat (Price, Sloman, Gardner, Gilbert, & Rohde, 1994; Taylor et al., 2011). This evolutionary strategy in animals functions to signal a submissive no-threat status to others, to withdraw from unachievable goals and to inhibit activity to avoid costs.

It has to be noted that social defeat and depression are not the same constructs (Shively, & Willard, 2012). Recently Shively and Willard (2012) reviewed the behavioral and neurobiological characteristics of social stress and the behavioral and neurobiological characteristics of depression in non-human primates. Both depressed and subordinate monkeys are found to have a perturbed HPA-axis. Furthermore the social subordinate as well as the depressed non-human primates respond with a higher initial heart rate and recover more slowly to a standardized stressor. However, the perturbations in autonomic functioning are more severe among depressed monkeys. Shively and Willard (2012) found that subordinates show different serotonergic and dopaminergic functioning compared to dominant monkeys. In contrast, no difference at the neurobiological level was found between depressed and non-depressed monkeys. Behavioral differences between subordinate and dominant monkeys arose in frequency of aggression received, submission sent or received, or in the percentage being groomed. Subordinates did also spent more time alone than dominants, which is interpreted as a lack of social support. None of these behaviors differed between depressed and non-depressed monkeys. Also dominant monkeys lived longer than

their subordinate counterparts. It is proposed that stress sensitivity may increase the likelihood of a depressive response to social stress (Shively, & Willard, 2012).

A study by De Jong, Van der Vegt, Buwalda, and Koolhaas (2005) investigating the effects of a single social defeat stressor in an animal sample, found that the long-term consequences of social defeat are modulated by the social housing conditions after the defeat. Animals that were housed individually after social defeat showed the most pronounced reductions in home cage heart rate, temperature, and activity during the dark phase (i.e., the dark period of the light/dark cycle, the dark period is normally the active phase for rats) and were the ones to show a decrease in body weight. The decrease of body weight after social defeat is prevented by social housing. The same study did not find behavioral effects of social defeat in response to a novel environment. The physiological responses, heart rate and temperature, to subsequent mild stressors were increased by defeat. The physiological response was not ameliorated by social housing (De Jong et al., 2005). Another study by Razolli and colleagues (2009) did find a behavioral response: socially defeated rats showed increased behavioral defensiveness, i.e., a decrease in rearing and self-grooming and an increase in risk assessment. Social withdrawal (defeated rats were less likely to visit the interaction zone) and passive behavior (during the forced swimming test the socially defeated rats showed less climbing and more floating) were also found as behaviorally responses affected by social defeat (Razolli et al., 2009).

Human studies

Social defeat Though the concept of social defeat has its origin in animal research the concept may inform human research as well. The effects of social defeat on humans are increasingly investigated. However, it is still a long way to go, especially as there are some obstacles to overcome (Björkqvist, 2001). Laboratory experiments of social defeat such as used in animal research cannot be applied to humans easily for behavioral and ethical reasons.

Behaviorally, human aggression is often instrumental rather than reactive. Social and cognitive factors do play a role in the reaction to social stress, preventing a primitive aggressive response to social stress to occur as in resident-intruder paradigm among rodents (Björkqvist, 2001). Social defeat in humans can arise from non-aggressive competition (Carvalho et al., 2013). It is the internal psychological sense of the position in the world humans have, which makes them capable of developing internal psychological social hierarchies in addition to the existing external social hierarchies. In humans, it may thus not be purely the immediate social context causing defeat, the subjective feeling of failure or loss may already cause this feeling (Taylor et al., 2011) with similar negative effects. According to Gilbert (2000, as described in Taylor et al., 2011) there are three main classes of events with the potential to induce perceptions of defeat, (1) a failure to attain or loss of valued resources, including social and material resources, (2) social put-downs or attacks from others, and (3) internal sources of attack. Social defeat in humans can thus be a perception of failure of internalized goals and self-perceptions rather than just external goals (Taylor et al, 2011).

For ethical reasons social defeat experiments are much harder to administer to human participants than to animals. It will not be ethically approved to expose human participants to (severe) experiences of social defeat (Björkqvist, 2001). Although it is hard to administer experiments regarding social defeat within a human sample, some experimental manipulations have been conducted with human participants and results are described below.

Social defeat and psychosocial consequences Engaging in a debate with a trained individual is considered as a stress inducing experience which may reflect acute social stress. Studies using this experiment are inconclusive; within males a relationship between submissiveness and higher heart rate and greater decrease in testosterone has been observed (Rejeski, Gagne, Parker, & Koritnik, 1989 as described in Björkqvist, 2001) whereas females did not show differences in testosterone. Another study found the dominant female

participants to have a stronger cardiovascular reactivity to the social stress experiment (Rejeski, Parker, Gagne, & Koritnik, 1990). Another experiment, involving five men who were confined on a boat for 14 days, showed a significant relation between hormonal levels and rank position for dominant behavior (Jeffcoat, Lincoln, Sleby, & Herbert, 1986). Social defeat appeared to reduce testosterone, but individuals low in testosterone may be less threatening to peers and therefore become socially defeated more easily (Björkqvist, 2001).

A natural condition showing interesting parallels with animal models of social defeat is bullying. This condition has informed the investigation of social defeat and its consequences in humans (Björkqvist, 2001). The purpose of bullying is to humiliate the victim and thereby increasing the bully's self-esteem and scaring others. Bullying does not have to be physical and is often of psychological nature. Symptoms of the bullied victims, both male and female, are depressive-like symptoms which, as pointed out before, may also be found in socially defeated rodents. Additionally, bully-victims show poor self-esteem and have a subjective feeling of maladjustment and dissatisfaction with school and peer relations (Björkqvist, 2001).

Social defeat has been studied mostly in relation to depression. Cross-sectional research with both clinical and non-clinical participants has found a positive correlation between self-reported defeat and depression (Taylor et al., 2011). In addition, suicidal risk and PTSD are positively correlated to defeat. Anxiety seems to be different from depression as anxiety seems to be driven by perceptions of future threat rather than past defeats (Taylor et al., 2011). The review by Taylor and colleagues concludes that the evidence for an association between defeat and anxiety disorders is sparse as only a small number of cross-sectional studies are conducted which showed mixed results. Although it is generally assumed that social defeat is a risk factor for the development of psychopathology, the direction of causality cannot be determined.

Social defeat in ethnic minorities

Social defeat and its relationship with the development of schizophrenia have been investigated in ethnic minorities. Long-term exposure to the experience of social defeat have been found to increase the risk for schizophrenia (Selten, & Cantor-Graae, 2007; Selten, Van der Ven, Rutten, & Cantor-Graae, 2013). In these studies, social exclusion experienced by immigrants is interpreted as a social defeat condition as it may reflect a subordinate position or outsider status. The risk for the development of schizophrenia is found to be greater for second generation immigrants than for first generation immigrants. It is proposed that this is because it is more humiliating to feel unwelcome in the country you are born in, than feeling unwelcome in a host country (Selten, & Cantor-Graae, 2007). Moroccan immigrant males in the Netherlands deal with high rates of unemployment and are overrepresented in crime rates. This group of immigrants also experiences the highest level of discrimination in the Netherlands. It was suggested that Moroccan participants in above-mentioned studies experience social defeat more frequently compared to Dutch nationals. The risk to develop schizophrenia in Moroccan females was not found to be increased, probably because the females experience a considerable rise in social status as they receive education and career opportunities in the Netherlands (Veling et al., 2006). In addition, males seem to feel more pressure to achieve a social rank compared to females in general (Aleman, Kahn, & Selten, 2003). In short, both gender and a generation effect seem to matter in the perception of social defeat. In human research strong social and family networks which characterize some ethnic groups, are supposed to diminish the negative effects of social defeat in the development of schizophrenia (Selten, & Cantor-Graae, 2007).

Adolescence

Adolescence is suggested to be a sensitive period during which the individual is vulnerable to the effects of the social environment (Spear, 2000). During the adolescent phase,

cortical development is rapid and reorganization of the hippocampus, prefrontal cortex and the amygdala takes place (Spear, 2000; Crews, He, & Hodge, 2007). It is suggested by animal studies that the impact of stress may not be the same during different developmental phases (McCormick, & Mathews, 2010; Romeo, 2010). Additionally, it is supported by animal studies that the effects of social stress in adolescence can endure through adulthood (Weintraub, Singaravelu, & Bhatnager, 2010). Social isolation of rodents during adolescence resulted in a decreased HPA response to restrain and a reduced state of anxiety based on behavior in the elevated plus maze in adulthood. It should however be noted that effects of other social stressors in adolescence, such as threats by predators or novel conspecifics, may result in different functional outcomes in adulthood (Weintraub, Singaravelu, & Bhatnager, 2010).

Current study

The aim of the current study is to examine the social defeat construct in a human sample. Social defeat is a latent construct, reflecting the perception of failed struggle related to the loss of status, identity or resources. It will first be examined how social defeat features in adolescent males. In addition it is explored whether the physiological reactivity (i.e. heart rate and skin conductance) of human individuals is similar to the findings in animal research. Is there a relationship between social defeat, physiology and internalizing psychopathology?

In response to the research paradigm it is hypothesized that individuals who experience social defeat have higher baselines of heart rate and skin conductance. They will also have a stronger response to stress and need a longer heart rate recovery period in comparison to individuals who did not experience social defeat. It is expected that this physiological reactivity is positively correlated to psychopathology (e.g., anxiety or depressive symptoms).

It is also hypothesized that individuals experiencing social defeat, but who perceive social support of friends and family have less negative effects both physiologically and behaviorally, than individuals experiencing social defeat without the perception of social support.

Method

Study background

This study is part of the larger ongoing 'LifeQuest'-study, investigating social defeat as an explanation for the relationship between ethnic minorities and psychosocial and severe behavioral problems. The 'LifeQuest' study consists of a screening phase and a follow up phase. In the screenings phase youth between 12 and 18 are requested to fill out an online questionnaire. Participants are recruited through schools of a lower or intermediate vocational educational level, located in several provinces in the Netherlands (i.e., Noord-Holland, Zuid-Holland, Zeeland and Utrecht).

Twenty percent of the participants in the screenings phase are invited to participate in the follow-up phase. These participants are either scoring very high (≥9) or very low (≤5) on the conduct dimension of the Strength and Difficulty Questionnaire (SDQ) and have to be male. Females are not included in the follow-up phase. Firstly, as females may perceive social defeat differently (Selten & Cantor-Graae, 2007) and secondly because social defeat experiments in animals are mainly conducted with males. In addition, it seemed not feasible given the financial resources to collect representative data for both sexes. A second group of male participants are recruited through child welfare institutions from all over the Netherlands. To be included in this group participants have to be aged between 12 and 18 years and have to show externalizing problem behavior. These participants fill out the screening questionnaire and perform the tasks of the follow-up phase in a single session. The

ethical board of the Faculty of Social Science approved of the study. The current study uses data from the follow-up participants and the participants from the child welfare institutions.

Participants

Based on the conduct subscale of the Strength and Difficulty Questionnaire, the male adolescents were divided into a low risk (LR) and a high risk (HR) group. Adolescents were assigned to the high risk group when they had a high score (i.e., ≥9) on the SDQ conduct scale. The total sample consists of 56 participants, 25 participants were assigned to the high risk group, the remaining 31 participants to the low risk group. There were no significant differences in age, SES, IQ or family size between low and high risk groups, see Table 1.

Of the total sample, 47 were Dutch nationals, the remaining nine had an immigrant background (i.e., either themselves or one of their parents was born abroad). The participants with an immigrant background were from various ethnicities, some were Moroccan (*n*=5), some Antillean (*n*=2) one German and one Cameroonian. Cross tabulation of 'Risk group' and 'Ethnicity' showed a non-significant Chi-square (χ^2 = .52, *p* =.472) reflecting no difference between the groups. However, it should be noted that one cell contained less than five observations.

Table 1

Descriptives of background variables Low versus High risk

		Low Risk		High Risk				
		M	*SD*	*M*	*SD*	*T*	*df*	*p*
Age	Years	15.74	1.63	15.08	1.69	1.47	53	.147
SES	Family affluence scale	12.71	2.24	12.88	2.70	-.26	54	.797
Family	Brothers and Sisters	2.19	1.38	1.96	2.49	.445	54	.658
IQ	Raven SPM	95.07	12.11	94.83	10.87	.07	52	.942

Procedure

A letter was sent to both the parents and the adolescent to inform them about the research and its procedure. Subsequently, a member of the research team called the eligible participants by telephone, and if they agreed to participate a home-visit was scheduled. Parents had to give permission by informed consent for their child to participate when their child was younger than 16.

During the home-visit, participants filled out a series of questionnaires assessing psychological health and self-esteem. Subsequently, they performed an implicit association task to assess their self-esteem. Thirdly, the Semi-structured Clinical Interview for Children and Adolescents (SCICA) was administered by a trained researcher. The content of the answers but also the duration and frequency on particular topics (e.g., conflict with peers, parents and other authorities) and observed behavior (e.g., eye-contact, giggling and hyperactivity) during the interview was scored directly after the session. Following, the seven electrodes (ConMed Cleartrace REF 2700-030) for the electrocardiogram (ECG) and the impedance cardiogram (ICG) were attached to the chest and back of the adolescent. The ECG electrodes were placed (as described in the manual version 1.1, 2013) (1) slightly below the right collar bone 4 cm to the right of the sternum, (2) on the right side, between the lower two ribs, and (3) on the left breast, 4 cm under the nipple. Electrodes for the ICG were placed (4) at the top end of the sternum, between the tips of the collar bones, (5) at the low end of the sternum, where the ribs meet, (6) at the back, on the spine, at least 3 cm above electrode 4, and (7) at the back, on the spine, at least 3 cm below electrode 5. The skin conductance electrodes were attached to the forefinger and middle finger of the non-dominant hand.

Next the Raven Standard Progressive Matrices (RSPM) was conducted to measure IQ and in the meanwhile the adolescent got used to the electrodes and its wires. Thereafter the participant was instructed to remain immobile for the duration of the affective research

paradigm. Participants were instructed to focus on crosses and pictures appearing on a laptop screen. External distractive noises, such as talking, someone walking with heels or a hard closing door, which may influence heart rate and skin conductance were written down for each time moment (i.e., during picture presentation or during the blank screen with the black cross). Finally, the participant filled out an affective 9-point-Likert scale for pleasure, arousal, and dominance named the Self-Assessment Manikin (SAM) designed by Lang (1980) about the pictures in the paradigm. Participants received a €20,- voucher for their participation.

Materials

In this study, Dutch versions of the following instruments were used.

Rosenberg Self-Esteem Scale (RSES). The RSES (Rosenberg, 1965) is probably the most used self-report questionnaire for adolescents to assess self-esteem. The RSES has been found to be a reliable and valid instrument to measure self-esteem (Gray-Little, Williams, & Hancock, 1997).A total of ten items, covering satisfaction about the self, needed to be answered on a four-point Likert-scale with a range from totally agree to totally disagree. Scores ranged from 10 to 40 with higher scores representing higher self-esteem. Reliability analysis showed an acceptable Cronbach's alpha of .82.

Implicit Association Task (IAT). The IAT measures self-esteem implicitly (Greenwald, & Farnham, 2000) by assessing automatic associations of self with positive or negative words. By measuring differences in reaction times a measure of self-esteem is created. The implicit association test consists 224 items.They are presented to the participants in 7 blocks of 24 or 40 items. Implicit measures of self-esteem show often low correlations with explicit measures (Greenwald, & Farnham, 2000; Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005) but can predict behavior reliably (Hofmann et al., 2005). A mete-analysis reviewed the predictive validity of Implicit Association Tests and found an average

of IAT- criterion correlation of .274 reflecting a moderate predictive validity (Greenwald, Poehlman, Uhlmann, & Banaji, 2009).

Multidimensional Scale of Perceived Social Support (MSPSS). The MSPSS is a self-report questionnaire, developed by Zimet, Dahlem, Zimet, and Farley (1988) to assess social support subjectively. The scale questions the amount of perceived social support of family, friends and significant others experienced by the adolescent. Twelve items with a seven-point Likert scale had to be filled out by the participants (Cronbach's $\alpha = .91$). High levels of social support are found associated with low levels of depression and anxiety (Zimet, et al., 1988). Zimet, Powell, Farley, Werkman and Berkoff (1990) studied the psychometric quality (i.e., reliability and validity) of the instrument among adolescents and found good reliability, strong factorial validity and valid subscales 'family' and 'significant others'. It should however be noted that the instrument tends to pull for social desirable responses (Zimet, et al., 1990).

Scale for Discrimination. The scale, consisting of four dichotomous questions, assesses the perceived personal and group discrimination. Participants had to declare whether they felt discriminated the past year based on their skin color, their origin, and their religion. When participants answered 'yes' a second question followed to find out how often this was the case 'once/ several times/ regularly/ often'. Group discrimination was assessed by asking the adolescents whether they felt their ethnic group is discriminated against in four situations (street, school, shops, and by the police). Reliability analysis showed a Cronbach's alpha of .72.

Family Affluence Scale (FAS). The Dutch version of the FAS was used to assess the social economical status of the family. The FAS uses items from deprivation indices of Townsend (1987) and Carstairs and Morris (1991). The FAS includes questions about the number of cars the family owns, the number of computers, the number of holidays taken the

past year, and whether the adolescent has its own room. The former three questions have three answer categories: ‘none’, ‘one/once’, ‘two/twice or more’. The latter can be answered with ‘yes’ or ‘no’. Boyce, Torsheim, Currie and Zambon (2006) found the scale to be a valid indicator of adolescents’ social economical status. Another question was added about the perceived wealth of the family, which has a 5-point scale.

Semi structured Clinical Interview for Children and Adolescents (SCICA). The Dutch version of the SCICA, developed by McConaughy and Achenbach (2001), was used to assess social-emotional and behavioral problems. Trained interviewers conducted the interviews. Both behavior and content were scored according to the scoring instructions of the manual. Behavior and content were scored on a range from 0 to 3, in which ‘0’ represents not observed, ‘1’ represents very little or doubtful observed, ‘2’ represents observed with low or moderate intensity and less than three minutes, and ‘3’ represents observed with high intensity or at least three minutes. Scores were given on 247 items by the interviewer directly after completing the interview. The items can be clustered in DSM-oriented scales.

Physiological measures The electrocardiogram (ECG), the impedance cardiogram (ICG) and the skin conductance was measured with the Vrije Universiteit-Ambulatory Monitoring System (VU-AMS). All electrodes were connected with lead wires to the VU-AMS-device. Recording took place only during the research paradigm, which will be described underneath. The physiological indices, heart rate (HR in bpm) and skin conductance level (SCL in μS) are obtained automatically with the Vrije Universiteit Data, Analysis and Management Software v3.2 (VU-DAMS). The sympathetic nervous system is activated during stress. Both heart rate and skin conductance levels are considered measures of the sympathetic nervous system (Fechir et al., 2008).

Research Paradigm The paradigm starts with three sample images, one of each condition negative, neutral and positive. All participants were presented eight neutral, eight

negative and eight positive pictures in a counterbalanced order. Between each image a blank screen with a cross in the middle was shown. The presentation duration of both images and blank screens were variable to prevent participants to develop some kind of expectation pattern. Durations varied between 10 and 13 seconds. The 24 pictures were selected from the international affective picture system (Lang, Bradley, & Cuthbert, 2005)[1]. In Figure 1 example pictures of a negative, neutral and positive condition are displayed.

Figure 1. Example of a negative, neutral, and positive picture.

Statistical Analysis

Social defeat concept As an indicator of social defeat two measures of self-esteem are interpreted, the Rosenberg-self-esteem scale (RSES) and the Implicit Association Task (IAT). These continuous variables were entered as predictors in the regression analyses. The implicit measure is of significant importance as this is less biased by the need to represent the self in a socially acceptable manner (Selton & Cantor-Graae, 2007).

Low and high risk groups Analyses of variance and *t*-tests were conducted to test the behavioral and physiological differences between the low and high risk groups. Secondly, regression analysis was conducted to examine the relation between self-esteem and physiological measures and internalizing problems. In addition, the relation between self-esteem, physiology and externalizing problems was examined by regression analysis. The regression analyses were performed with both the whole sample and the separate risk groups. As a consequence of the sample selection criteria of the larger 'LifeQuest' study, the sample is drawn from two different populations. To control for possible confounding relations and to

[1] The IAPS slide numbers were as follows: pleasant, 1710, 1920, 2070, 2332, 5480, 7330, 8490, 8510; neutral, 7001, 7006, 7009, 7010, 7026, 7080, 7100, 7150; negative, 2457, 2703, 2900, 9000, 9002, 9295, 9421, 9471.

prevent drawing unreliable conclusions separate analyses are conducted, although this affects the power.

Data inspection One adolescent decided to abort his participation for unknown reasons. The interview and physiological data of this participant were incomplete and therefore not analyzed. The available data (self-esteem scores and answers on the questionnaires) were used in the remaining analyses. In addition, physiological data of four participants were missing due to instrument failure (i.e., labels were not sent to the VU-AMS device so label information could not be obtained). Therefore, analyses with physiological data were executed with $N = 51$.

One outlier in heart rate was detected during all conditions (i.e., neutral, positive and negative condition). It was decided to change this value to the next highest extreme value in each condition. On skin conductance there were three outlying variables, the same procedure as described above was applied to these outliers.

The positively skewed variables of the SCICA scale were not transformed, as this is representative of the population distribution. This should however be taken into account when interpreting the results. For interpretation purposes the slightly skewed variable of social support is not transformed.

Results

Preliminary analysis

Table 2 displays the means (*M*), standard deviations (*SD*), *t*-tests, and *F*-tests of the variables used in the analyses between the low- and high risk participants. Significant differences were found for self-report self-esteem (t (54) = 2.80, p <.01). Low risk participants scored significantly higher on the explicit self-esteem measure compared to the high risk participants.

A trend was visible for heart rate, where there was a lower heart rate for the low risk compared to the high risk group.

The heart rate in the neutral condition of the affective research paradigm did not meet the assumption of a baseline measure. The neutral condition was found to have the highest heart rate compared to the negative condition, and marginally to the positive condition ($t(50) = -3.66$, $p = .001$, and $t(50) = -2.00$, $p = .051$, respectively). In addition, the recovery period seemed not to function as such, as heart rate was rising instead of declining in the set recovery period. For these reasons it was decided to combine the conditions to one measure of individual physiological level which was used in the following analyses. Similarly, no differences were observed in skin conductance levels among the conditions in the affective research paradigm 'neutral – negative', 'neutral – positive' or 'negative – positive' ($t(50)= 1.31$, $p = .196$, $t(50) = -.248$, $p = .805$, and $t(50) = -1.59$, $p = .118$ respectively). As the conditions of the research paradigm did not discriminate, the conditions were combined to one general measure of skin conductance level.

A one-way MANOVA was performed to determine whether there were differences between the low and the high risk group regarding the scales of the SCICA. The MANOVA revealed a non-significant multivariate effect for low/high risk group (Wilks' $\lambda = .78$, $F(8, 42) =1.50$, $p = .188$). Univariate analyses of the subscales were not examined as the whole model was not significant. Performance of the MANOVA on DSM scales (of the SCICA) did not show a multivariate effect (Wilks' $\lambda = .82$, $F(7, 46) =1.45$, $p = .208$), therefore no univariate analysis was performed. A separate MANOVA was performed for the internalizing and externalizing scale of the SCICA which revealed a multivariate main effect for low/high risk group (Wilks' $\lambda = .87$, $F(2, 50) =3.68$, $p = .032$, partial $\eta^2 = .128$). Univariate examination showed a significant effect of externalizing behavior ($F(1, 51) = 4.67$, $p = .035$, partial $\eta^2 =.084$), which implied a higher externalizing score for the high risk group.

The associations between the behavioral and the physiological measures are displayed in Table 3. Explicit self-esteem was negatively correlated to discrimination, a higher level of discrimination went along with a lower explicit self-esteem. A positive correlation was found between externalizing problems and internalizing problems. Heart rate was found positively correlated to both internalizing as externalizing problem behavior.

Table 2

Descriptive statistics for the Low risk group and the High risk group

		Low risk			High risk					
		N	*M*	*SD*	*N*	*M*	*SD*	*t*	df	*p*
Implicit Self-esteem		28	.38	.31	23	.43	.41	-.47	49	.641
Explicit Self-esteem		31	31.84	4.63	25	27.92	5.83	2.80	54	**.007**
Social Support		31	67.71	14.72	24	67.46	13.72	.07	53	.949
Discrimination		31	2.16	2.38	22	2.55	2.84	-.53	51	.596
SES		31	12.71	2.24	25	12.88	2.70	-.26	54	.797
Heart rate		27	69.61	9.46	24	74.15	7.44	-1.78	49	.084
Skin conductance		27	6.60	3.37	24	5.97	2.94	.72	49	.478
								F	df	*p*
SCICA	Internalizing	30	11.97	9.58	23	10.30	7.72	.46	1	.500
	Externalizing	30	19.77	14.18	23	27.61	11.44	4.67	1	**.035**

Note. Bold script represents significant tests, $p < .05$

Table 3

Associations between behavioral and physiological measures

	Discrimination	SES	Social Support	Implicit Self-esteem	Explicit Self-esteem	Internalizing problems	Externalizing problems	Heart rate
Discrimination								
SES	-.05							
Social support	.08	.26						
Implicit Self-esteem	-.25	-.01	.06					
Explicit Self-esteem	**-.29***	.02	-.07	.03				
Internalizing problems	.20	-.04	.08	-.14	-.17			
Externalizing problems	.11	-.21	.13	-.04	-.13	**.35****		
Heart rate	.16	-.09	.16	-.15	-.15	**.36***	**.42****	
Skin conductance	-.27	-.21	-.14	-.22	-.00	-.10	.02	.14

Note. Bold script represents significant correlations. *p <.05, **p <.01

Ethnic disadvantage and social defeat

To test whether there was a difference on various measurements between Dutch nationals (n = 45) and participants with an immigrant background (n = 9), t-tests were conducted. Results are displayed in Table 4. No significant differences were found. A multivariate analysis of variance of internalizing and externalizing problem behavior was not significant, univariate analyses were therefore not carried out.

Table 4

Descriptives for Dutch nationals and participants with an immigrant background

		Dutch Nationals			Immigrant background					
		N	*M*	*SD*	*N*	*M*	*SD*	*t*	df	*p*
SES		45	12.84	2.36	9	11.56	1.88	1.54	52	.130
Discrimination		43	2.23	2.51	9	3.00	2.92	-.81	50	.420
Social support		45	67.62	14.31	9	66.22	14.50	.27	52	.790
Implicit Self-esteem		42	.39	.37	8	.48	.30	-.63	48	.532
Explicit Self-esteem		45	29.78	5.58	9	31.11	5.44	-.66	52	.514
Heart rate		41	72.40	9.07	8	69.55	7.81	.83	47	.411
Skin conductance		41	6.62	3.22	8	4.98	3.00	1.33	47	.191
								F	df	*p*
SCICA	Internalizing	43	11.60	9.38	9	10.11	5.82	*	*	*
	Externalizing	43	22.81	13.87	9	26.00	12.48	*	*	*

*Note. p <.05 * Univariate analyses are not carried out.*

Relation between behavioral and physiological measures and Internalizing Problem behavior

To examine the dependency of behavioral and physiological measures on internalizing problem behavior hierarchical multiple regression analysis was carried out. SES was entered in the first step of the regression analysis. Subsequently, both implicit and explicit measures of self-esteem were entered in the second step. As a third step the physiological measures,

heart rate and skin conductance, were entered. In the fourth and final step social support was added to the model. Tests for multicollinearity indicated low levels of multicollinearity (all variables had a variance inflation factor (VIF) below 1.15). The explained variance by the third model was rather small (R^2 = .17). Adding the social support variable did not increase the explained variance.

Separate hierarchical analyses were carried out for each risk group. The linear regression models for the separate risk groups had explained variances of 33% and 34% for respectively the low and the high risk group. Low levels of multicollinearity in both the low and the high risk groups were indicated, VIF < 1.41 and VIF < 1.39 respectively. In Table 5 the results for predicting internalizing problems is summarized.

The best model fit in predicting internalizing problem in the low risk group was a linear combination of SES, discrimination, implicit and explicit measures of self esteem and the physiological measures heart rate and skin conductance (R^2 = .33, F (5, 19) = 1.87, p = .148). Adding social support into the regression model did not significantly improve the prediction (R^2change = .004, F(1,18) = .113, p =.741). Introducing the physiological measures in step three, contributed significantly to the regression model (F(2, 19) = 3.69, p = .044), accounting for an additional 26% of the explained variance in internalizing problem behavior. In the third regression model, including five independent variables, heart rate was the only significant predictor of internalizing problem behavior (β = .52, t(19) = 2.64, p = .016) uniquely explaining 25% of the variance of the model in predicting internalizing problem behavior.

Explicit self-esteem was a significant predictor in the second step of the linear regression model (β = -.45, t(17) = -2.16, p = .046), with the model explaining 29% of the variance. Adding the physiological measures in step 3 diminished the effect of explicit self-esteem. In both the third and final model there were no significant predictor variables.

Relation between behavioral and physiological measures and Externalizing Problem behavior

The same regression analyses were performed with externalizing problem behavior. Again, SES was entered in the first step of the hierarchical multiple regression analysis. In the second step the implicit and explicit measures of self-esteem were entered. In the third step the physiological measures, heart rate and skin conductance, were added. In the final step social support was entered. Tests for multicollinearity indicated low levels of multicollinearity (all variables VIF < 1.15). The best fitting model for predicting externalizing behavior in the total sample was a linear combination of SES, implicit and explicit measures of self esteem and the physiological measures heart rate and skin conductance (R^2 = .32, F(5, 41) = 3.78, p = .007). Adding the social support variable did not significantly improve the prediction (R^2change = .001, F(1,40) = .05, p = .823). A summary of the results of the hierarchical regression analysis in predicting externalizing behavior in the total sample is displayed in Table 6. When all six variables were included in step four of the analysis, heart rate remained the only significant predictor of externalizing problem behavior (β = .41, t(40) = 2.94 , p = .005). The unique variance explained by the predictor was r^2 = .15.

For each risk group a separate hierarchical analysis was carried out. Predicting externalizing problems in the low risk group showed the best model fit for the linear combination of SES, implicit and explicit measures of self esteem and the physiological measures heart rate and skin conductance (R^2 = .49, F(5, 19) = 3.67, p = .017). Adding social support to the model did not significantly improve the prediction (R^2change = .003, F(1, 18) = .10, p =.761), but it did diminish the predictive effect of heart rate. In Table 6 the results are displayed. SES remained a significant predictor in all steps of the hierarchical regression. In the final model SES uniquely explained 33% of the variance (β = -.60, t(18)=-3.42, p=.003).

Although the explained variance of the model was 45%, none of the variables was a significant predictor of externalizing behavior in the high risk group.

Table 5.

Summary of hierarchical regression analysis for variables predicting internalizing problem behavior.

		Step 1	Step 2	Step 3	Step 4
Internalizing (*N* = 46)	SES	-.03	-.04	-.05	-.06
Total sample					
	Implicit Self-esteem		-.15	-.14	-.15
	Explicit Self-Esteem		-.14	-.11	-.11
	Heart Rate			.33	.32
	Skin conductance			-.19	-.19
	Social Support				.02
	R^2	.01	.04	.17	.17
	ΔR^2		.04	.12	.00
Internalizing	SES	-.26	-.26	-.23	-.22
Low Risk (*n* =25)	Implicit Self-esteem		-.02	.05	.07
	Explicit Self-Esteem		.05	-.02	-.03
	Heart Rate			**.52***	**.55***
	Skin conductance			-.16	-.18
	Social Support				-.08
	R^2	.07	.07	.33	.33
	ΔR^2		.00	**.26***	.00
Internalizing	SES	.26	.15	.14	.24
High Risk (*n* =21)	Implicit Self-esteem		-.20	-.20	-.22
	Explicit Self-Esteem		**-.45***	-.44	-.49
	Heart Rate			.07	.07
	Skin conductance			-.06	.00
	Social Support				-.22
	R^2	.07	.29	.30	.34
	ΔR^2		.22	.01	.04

Note. In Bold face the significant predictors, *p <.05. R^2 = explained variance. ΔR^2 = the additional explained variance as compared to the preceding model.

Table 6

Summary of hierarchical regression analysis for variables predicting externalizing problem behavior

		Step 1	Step 2	Step 3	Step 4
Externalizing (*N* = 47)	SES	-.26	-.27	-.27	-.27
Total sample					
	Implicit Self-esteem		-.15	-.12	-.12
	Explicit Self-Esteem		-.25	-.21	-.21
	Heart Rate			**.41***	**.41***
	Skin conductance			-.14	-.13
	Social Support				.03
	R^2	.07	.15	**.32***	**.32***
	ΔR^2		.08	**.17***	.00
Externalizing	SES	**-.57***	**-.61***	**-.59***	**-.60***
Low Risk (*n* = 25)	Implicit Self-esteem		.14	.25	.23
	Explicit Self-Esteem		.09	.07	.08
	Heart Rate			**.39***	.36
	Skin conductance			.00	.02
	Social Support				.06
	R^2	**.33***	**.35***	**.49***	**.49***
	ΔR^2		.02	.14	.00
Externalizing	SES	.09	-.04	.01	.08
High Risk (*n* = 22)	Implicit Self-esteem		-.38	-.34	-.35
	Explicit Self-Esteem		-.36	-.31	-.35
	Heart Rate			.41	.39
	Skin conductance			.01	.06
	Social Support				-.18
	R^2	.01	.26	.42	.45
	ΔR^2		.25	.16	.03

Note. In Bold face the significant predictors, *p <.05. R^2 = explained variance. ΔR^2 = the additional explained variance as compared to the preceding model.

Discussion

Earlier animal studies have suggested that social defeat causes physiological and behavioral changes in response to stress (Björkqvist, 2001; Taylor et al., 2011). The aim of the present study was to examine the concept of social defeat in an adolescent male sample, by measuring physiological changes during an affective research paradigm. It was hypothesized that higher baselines of heart rate and skin conductance is characteristic for individuals who experience social defeat. In addition, it was hypothesized that the social defeated individuals would have a stronger response to stress inducing images and that they would need a longer heart rate recovery period in comparison to individuals who did not experience social defeat. It was expected that (part) of the effect(s) of defeat could be prevented by social support.

Ethnic disadvantage and social defeat

Considering social defeat as an 'experienced minority position in society', immigrants may fit easily. In this study it was found that ethnic disadvantage did not lead to differences in the behavioral and the physiological characteristics theoretically belonging to the concept of social defeat. No differences in SES, discrimination or self-esteem between Dutch nationals and participants with an immigrant background became apparent. Physiologically no alterations were observed among the participants with an immigrant background. This finding is in contradiction with studies showing migrant status, as an indicator of social defeat, associated with an increased risk for psychotic disorders (Selten & Cantor-Graae, 2005; Selten et al. 2013). This inconsistency might be explained methodologically as the sample size of the group with an immigrant background in the present study was rather small. Alternatively, a study by Veling and colleagues (2008) found the risk to develop a psychotic disorder in ethnic minority individuals to be moderated by neighborhood ethnic density. It was found that the risk is elevated for immigrants living in neighborhoods with a small

proportion of their own ethnic group. This neighborhood factor was not taken into account in the present study and this may have affected the results. Possibly, participants with an immigrant background were living in a neighborhood with a high density of their own ethnicity, preventing them from the risk of psychopathology or from the risk of social defeat

Contrary to this study by Veling and colleagues (2008) is the study of Bellmore, Witkow, Graham, and Juvone (2004). They suggest a larger effect on physiological health of social exclusion for those belonging to the ethnic majority compared to belonging to the ethnic minority. This study is in line with the found results.

These contradictory findings require further research in which the effect of belonging to a minority or majority ethnicity on the perception of social defeat should be examined carefully.

Low versus high risk group and social defeat

Since the present study was based on data from a larger study in which a low risk and a high risk group for conduct problems were selected, the present analyses were performed separately for these two subgroups. The low risk group reported a higher self-esteem compared to the high risk group, which is in line with the literature. Low self-esteem is found associated with aggression, antisocial behavior and delinquency regardless of IQ, SES, or social support (Donnellan, Trzesniewski, Robins, Moffitt, & Caspi, 2005). Results revealed more externalizing problem behavior in the high risk group, which is expected as conduct problems were the selection criteria which is covered by externalizing problems.

Internalizing problem behavior

In the low risk group internalizing problems were found to be predicted by heart rate. It should, however, be noted that statements of causality are not allowed given the cross-sectional nature of the study design. Therefore, it may only be concluded that a high heart rate is related to more internalizing problem behavior. This result complies with the literature. For

instance, the study by Zahn-Waxler, Klimes-Dougan and Slattery (2000) mentioned a relation between anxiety disorders and depression and higher resting heart rates among children and adults.

Within the high risk group the predictive value of explicit self-esteem was diminished by adding the physiological measures into the regression model. A higher self-esteem is related to less internalizing problem behavior, which is in line with the literature (Zeigler-Hill, 2011). As heart rate and skin conductance affected this association, an overlap in the explained variances is suggested. It is argued that these mind and body aspects are inextricably linked to one another and cannot interpret solely as indicators of social defeat.

None of the models predicting internalizing problems were accompanied by a significant ANOVA (test whether the model is significantly better at predicting the outcome than using the mean as a best guess) which implies results should be interpreted with care. This might be due to the small sample size. Rule of thumb for successfully performing these analyses, is ten participants for each predictor in the regression analysis, which was unfortunately not the case in this study. It is recommended to replicate in the study using a larger sample.

Externalizing problem behavior

SES was found to be a significant predictor of externalizing problem behavior in the low risk group. As mentioned before, the design does not allow for statements of causality. An increase in SES was related to a decrease in externalizing problems. Literature supports this finding, Van Oort, Van der Ende, Wadsworth, Verhulst, and Achenbach (2011) did also find SES to predict externalizing behavior problems. Though, they also found SES to predict internalizing problem behavior which was not found in the present study. Poor representativeness of the population could be an explanatory factor.

The effect of heart rate, in the prediction of externalizing problem behavior, was diminished by social support. This finding is in concordance with the hypothesis suggesting social support as a protective factor for the negative effects of social defeat. This protective factor shows similarities to the social housing in animal studies (De Jong, et al., 2005), mentioned in the introduction.

The absence of any result in the high risk group might again be explained by the study's design. The high risk group was selected based on self reports of conduct problems, which was the outcome measure in the regression analysis, resulting in small variances. It is therefore recommended to draw a more general sample of the male population of adolescents in future research.

Affective research paradigm

The affective research paradigm was not able to elicit sympathetic activity, it could not discriminate between the different picture conditions: positive, neutral and negative. The affective pictures, derived from the international affective picture system, might not be sufficiently stress inducing. During intense emotional states, heart rate would accelerate, but milder emotional stimuli cause heart rate deceleration (Palomba, Angrilli, & Mini, 1997). In this study the pictures were apparently mild emotional stimulations. This could explain the deceleration for the negative condition but not the deceleration during the positive condition.

Similarly, skin conductance did not vary between the different conditions. Again the emotional strain of the stimuli might be an explanation. In addition, it should be mentioned that skin conductance is easily influenced by surroundings such as temperature or humidity. As the data-collection took place at the homes of the participants, the environmental factors could not be controlled.

Visual inspection of the skin conductance levels over the duration of the affective research paradigm showed a decreasing line for almost all participants. Habituation seemed to

be the case. Analysis of solely the first 8 pictures, which would be a preferable solution, was not possible due to the counter balancing order of the affective pictures presentation.

Social defeat concept

Unfortunately, the research question, whether similar behavioral and physiological effects are found for social defeat in a human sample, remains unanswered. The main shortcoming is the measurement of social defeat. Recalling the previous described definition of social defeat: the perception of failed struggle related to the loss of status, identity or resources, you could argue what the best measurement would be. In this study SES and discrimination are used as a risk factor for social defeat. Subsequently, measures of self-esteem and heart rate were examined as indicators of social defeat. Selten and colleagues (2013) proposed a model of social defeat where it is a common mechanism of six major risk factors for schizophrenia, low IQ, urban upbringing, migration, illicit drug use, childhood trauma and psychiatric disorders. The risk factors are not specific to the development of schizophrenia (Selten et al., 2013), they may also underlie internalizing or externalizing problem behaviors (Velez, Johnson, & Cohen, 1989; Deater-Deckard, Dodge, Bates, & Pettit, 1998) and even more risk factors could be added. Social defeat can probably best be modeled as a dynamic process in which risk and protective factors interact constantly, but character traits such as resilience and coping style could play an important role as well. In Figure 2 a model of social defeat is proposed.

Social defeat is depicted as an underlying mechanism of the working of various risk and protective factors but character traits may be of significant importance as well. The relationship of social defeat with internalizing and externalizing behavior as well as the relationship with self-esteem and physiology is proposed as a dynamic one. Social defeat may lead to problem behavior and low self-esteem and higher baseline heart rate and skin conductance, but low self-esteem and high baseline heart rate and skin conductance may

make someone also susceptible for the experience of social defeat. This mechanism was also described by Björkqvist (2001): individuals low in testosterone may be less threatening to peers and therefore become socially defeated more easily. It could also be the other way around in which social defeat reduces testosterone. A longitudinal design may enable more insight in these reciprocal relationships.

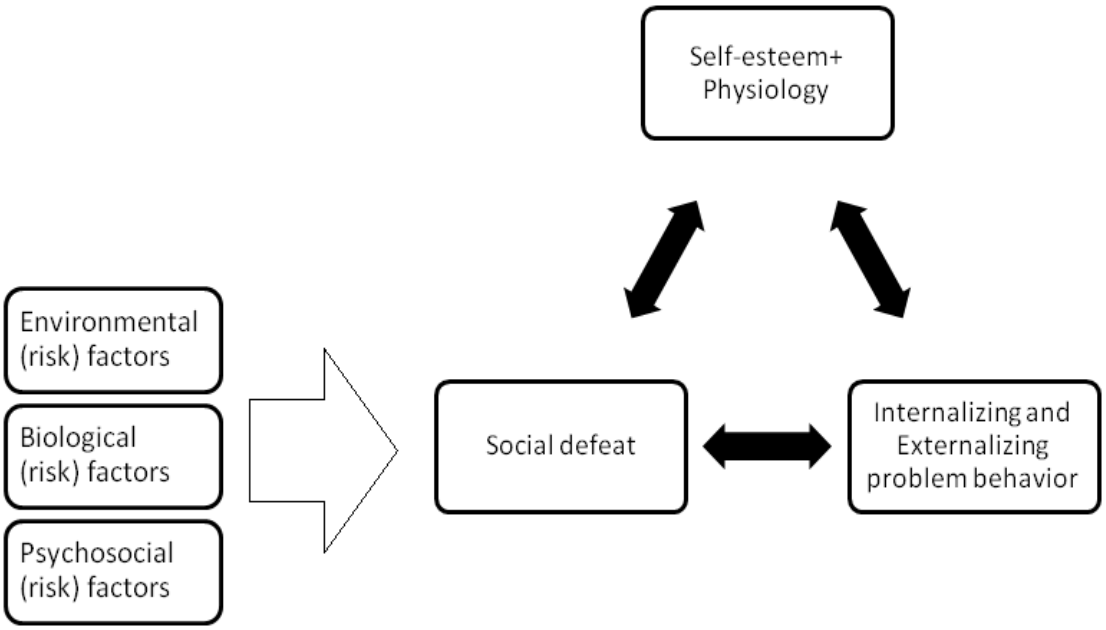

Figure 2. Social defeat model. Environmental, biological and psychosocial factors interact and can lead to the perceived feeling of defeat, this in turn can lead to low self-esteem and altered physiology. Low self-esteem and altered physiology may also contribute to the perception of social defeat. Social defeat may also affect problem behavior and/or the other way around. This model is proposed as a dynamic process.

Conclusion and recommendations

Unfortunately, the study was not able to test the concept of social defeat fully, as the sample was collected as part of another study and (sub)sample sizes were small. Among the ethnic minority group there were no signs of social defeat. Differences in physiology (i.e. heart rate) among the low risk group and the high risk group were not observed. Therefore, no statements can be made about similarities with results of animal studies. However, in the present sample, a relationship between physiology (i.e. heart rate) and internalizing

psychopathology was found. Assuming social defeat to cause a physiological alteration, this is a promising finding. The hypotheses about the physiological reactivity in response to the affective research paradigm could not be tested. In one specific analysis social support diminished the effect of heart rate on externalizing problems; this hypothesis should be tested again in future studies.

The biggest shortcoming of this study and probably the main reason to leave the research question(s) unanswered is related to the sample. As it was part of another study, selection criteria were not designed for the present study, resulting in a small sample size and a very small subsample of participants with an immigrant background in particular. Future research should draw a sample from the total male adolescent population with a larger percentage of participants from an ethnic minority. Another limitation was the designed affective research paradigm, which appeared to insufficiently elicit stress. In future studies it is recommended to use a more reliable stress tasks, such as the Trier Social Stress task (Kirschbaum, Pirke, & Hellhammer, 1993).

Providing insight in the concept of social defeat in a male adolescent sample is therefore difficult to achieve. As proposed before, social defeat might be a more dynamic process than anticipated. To capture this dynamic process of social defeat, a cross-ethnic longitudinal design should be carried out. Insight in the concept of social defeat may inform, in the future, about prevention programs or treatments for those individuals who are socially defeated or who are susceptible for social defeat.

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