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Sensory-Processing Sensitivity predicts treatment response to a school-based depression prevention program: Evidence of Vantage Sensitivity

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ABSTRACT

Objective: Treatment effects of preventative mental health interventions for adolescents tend to be relatively small. One reason for the small effects may be individual differences in the response to psychological treatment as a function of inherent characteristics, a notion proposed in the concept of *Vantage Sensitivity*. The current study investigated whether the personality trait Sensory-Processing Sensitivity moderated the efficacy of a new school-based intervention aimed at the prevention of depression.
Method: Using a two-cohort treatment/control design with one cohort serving as the control group ($N = 197$) and a subsequent cohort as the treatment group ($N = 166$) it was tested whether Sensory-Processing Sensitivity predicted depression trajectories from pre-treatment up to a 12 months follow-up assessment in 11-year-old girls from an at-risk population in England.
Results: Sensory-Processing Sensitivity emerged as a significant predictor of treatment response. The prevention program successfully reduced depression scores in girls scoring high on Sensory-Processing Sensitivity but was not effective at all in girls scoring low on the same measure.
Conclusions: This study provides first empirical evidence for *Vantage Sensitivity* as a function of the personality trait Sensory-Processing Sensitivity regarding treatment response to a school-based depression prevention intervention.

1. Introduction

Rising rates of depressive disorders during childhood and adolescence pose a major public health concern in most Western societies (e.g., Collishaw, Maughan, Goodman, & Pickles, 2004). Not only are depressive symptoms in adolescence often associated with social, academic, and physical health difficulties, but they also tend to predict subsequent major depression in adulthood (Aalto-Setala, Marttunen, Tuulio-Henriksson, Poikolainen, & Lonnqvist, 2002). Children growing up in economically deprived neighborhoods (Yoshikawa, Aber, & Beardslee, 2012) and girls (Hyde, Mezulis, & Abramson, 2008) are at a particularly high risk for the development of depressive disorders. According to a recent study in England the percentage of youth reporting frequent feelings of depression and anxiety doubled over the last two decades, with girls being almost three times more likely to suffer from depression/anxiety than boys (Collishaw, Maughan, Natarajan, & Pickles, 2010).

Given the detrimental effects of depression and the recent increase of depressive disorders in adolescent populations, substantial efforts have been directed towards the prevention of depression in childhood—usually through school-based promotion of adaptive coping skills and related competencies (Sutton, 2007). According to several meta-analyses such preventative interventions have generally been found effective regarding the reduction of depression symptoms (Brunwasser, Gillham, & Kim, 2009; Horowitz & Garber, 2006; Stice, Shaw, Bohon, Marti, & Rohde, 2009). However, the average treatment effects tend to be modest at best ($r = .11–.24$) and treatment efficacy appears to vary as a function of intervention delivery and sample demographics (Brunwasser et al., 2009; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Horowitz & Garber, 2006; Stice et al., 2009). What has been neglected in existing work, until very recently (Eley et al., 2012), is the notion that intervention effects may differ as a function of inherent child characteristics (e.g., personality

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traits, genetics). It is widely accepted that some individuals are more vulnerable to the negative effects of adversity as a function of individual traits, be they of psychological (Kochanska & Kim, 2012), physiological (Cummings, El-Sheikh, Kouros, & Keller, 2007), or genetic (Caspi et al., 2002) nature. Extending this *Diathesis-Stress* perspective (Zuckerman, 1999), the *Differential Susceptibility* framework (Belsky & Pluess, 2009) suggests that such inherent traits may not just increase vulnerability to adversity but rather sensitivity to a variety of environmental influences, with more susceptible individuals being more affected by both *negative as well as positive* experiences (Pluess, in press). In other words, the same characteristics that make children more vulnerable to adverse experiences may also make them more responsive to beneficial exposures (Belsky & Pluess, 2009). The proposition—derived from *Differential Susceptibility* reasoning—that individuals may differ generally in their response to positive experiences as a function of inherent characteristics has recently been articulated in more detail in the concept of *Vantage Sensitivity* (Pluess & Belsky, 2013). According to this framework some people are more likely to benefit from positive exposures while others appear to be less responsive or even resistant to the positive effects of the same supportive experience. The suggested reason for such differences in response to positive experiences is that people differ fundamentally in their environmental sensitivity with some being more and some less sensitive (Pluess, in press). Although a fairly new concept, a growing body of empirical evidence reports individual differences in *Vantage Sensitivity* as a function of different psychological, physiological, and genetic characteristics in response to a wide range of positive exposures—including psychological intervention (for an overview, see Belsky & Pluess, 2013). For example, in their pioneering experimental study evaluating genetic moderation of a psychological intervention, Bakermans-Kranenburg, van IJzendoorn, Pijlman, Mesman and Juffer (2008) investigated whether a genetic polymorphism in the dopamine receptor D4 (DRD4) gene moderated the positive effects of a video-feedback parenting intervention on children's externalizing behaviour in a randomised controlled trial. Providing evidence for Vantage Sensitivity as a function of genetic differences of the child, the intervention proved effective in decreasing externalizing behaviour—but only for children carrying the DRD4 7-repeat gene variant. Children without this gene variant did not benefit from the intervention at all.

In the current study we sought to investigate Vantage Sensitivity as a function of *Sensory-Processing Sensitivity* (SPS)—a personality trait measured with the Highly Sensitive Person (HSP) Scale (Aron & Aron, 1997)—in response to a new universal school-based preventative depression intervention, the *SPARK Resilience* program (Boniwell & Ryan, 2009). About 20% of the general population is estimated to score particularly high on SPS, characterized by increased awareness and deeper processing of environmental subtleties as well as the tendency to be more easily overwhelmed when in very stimulating situations. SPS has been hypothesized to be the manifestation of a highly sensitive central nervous system, on which environmental influences register more easily and more deeply (2012). In a first experimental study 160 undergraduate students were randomly allocated to solve either very easy or very difficult math problems (Aron, Aron, & Davies, 2005). Students scoring high on SPS reported the highest negative affect when assigned to the "difficult" math problems condition but also the lowest negative affect when allocated to the "easy" condition, compared to students low on SPS in either experimental condition, providing the first empirical evidence that SPS may increase sensitivity to both negative and positive experiences.

The current study involved a sample of 363 11-year-old girls at a state school in one of the most deprived neighborhoods of England, representing the population most at risk for depressive disorders in the United Kingdom. Applying a nonrandomized two-cohort treatment/control design, the intervention was conducted in the treatment cohort only, which included all children in the same year at the same school, while the complete year-ahead cohort served as a control group. Based on the *Vantage Sensitivity* framework (Pluess & Belsky, 2013), it was hypothesized that girls scoring high on SPS would show a greater positive response (i.e., steeper decline of depression symptoms over time) to the preventative intervention than girls scoring low on SPS.

2. Method

2.1. Procedure

The SPARK Resilience program (Boniwell & Ryan, 2009) was delivered to all children of the same cohort in Year 7 (i.e., 6th grade) as part of the standard curriculum at a girls-only state school in East London, England. Data was collected on laptop computers during class at school, using an online questionnaire service, immediately before and after delivery of the program, as well as 6 and 12 months after the program was completed. The year-ahead cohort served as control group but was assessed only once at the end of school Year 8, exactly one year before the 12-month follow-up assessment of the treatment cohort was conducted. Consequently, the control data corresponds to the 12-month follow-up data of the treatment group, gathered when each of the cohorts were approaching the end of Year 8 (see Fig. 1 for flow chart).

2.2. Participants

The original evaluation study included 230 girls in the treatment and 208 in the control cohort (Pluess, Boniwell, Hefferon, & Tunariu, submitted). The current analysis is based on a subsample of 166 girls in the treatment cohort for whom data on SPS was available, and 197 girls in the year-ahead control cohort with completed depression questionnaires, resulting in a total sample of 363 participants. Due to failure to complete all questionnaires in time, and absences from school when data collection took place, sample size of the treatment cohort varied across repeated assessments with 141 girls at pre, 166 at post, 144 at 6-month, and 113 at the 12-month assessment (the statistical approach of the primary analysis allowed for inclusion of all 166 girls that provided data at least at one of the assessments). At the initial assessment, girls in the treatment cohort were on average 11.4 years old (SD = .49 years). There was no significant difference in age at the end of Year 8 between the treatment cohort at 12-months follow-up (M = 12.9 years, SD = .36) and the control cohort (M = 12.8 years, SD = .90). The sample was ethnically diverse, with 51.2% Asian, 18.1% Mixed, 19.3% African/Caribbean, 9.0% Caucasian, and 2.4% Middle Eastern in the treatment and 44.7% Asian, 17.8% Mixed, 29.4% African/Caribbean, 6.6% Caucasian, and 1.5% Middle Eastern in the control cohort. Distributions of ethnicities in treatment and control cohort were not significantly different (χ^2 = 5.63, p = .23). There were no significant differences in family size (both groups with M = 4.6 persons per household, SD = 1.81) or child-reported paternal education between treatment and control cohorts (both cohorts combined: 1.4% with less than secondary school, 19.6% with only secondary school, 20.4% with a university degree, 14.0% more than one university degree, and 44.6% unknown by the child). All children attended the same school in the borough of Newham, which was ranked the third most deprived area in all of England in the 2010 Index of Deprivation (Department for Communities and Local Government, 2011).

The study received ethical approval from the University of East London research ethics committee.

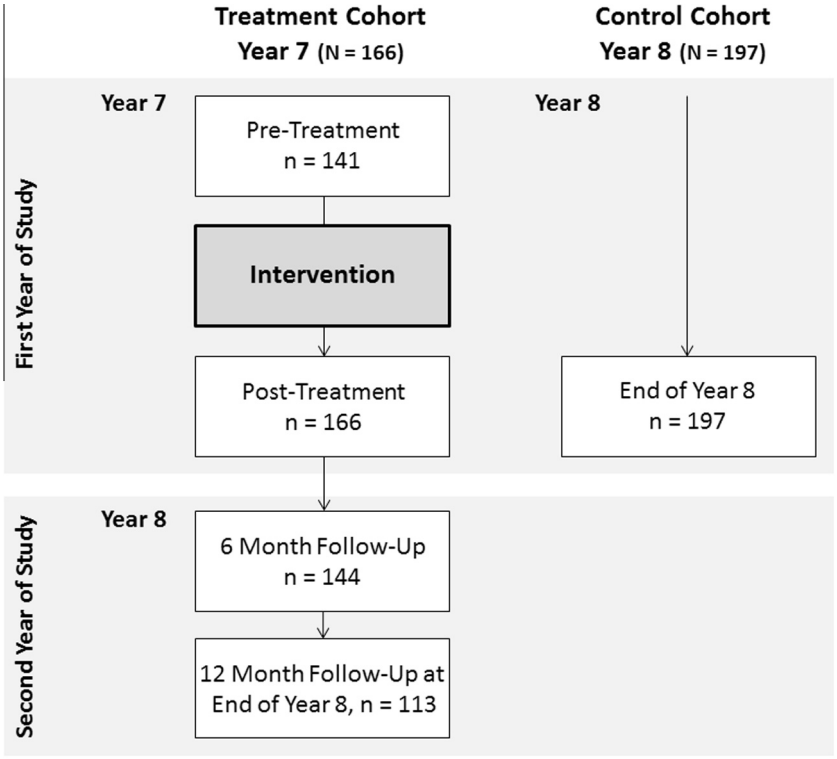


Fig. 1. Flow chart of the applied nonrandomized two-cohort treatment/control design.

2.3. Intervention

The *SPARK Resilience* program is a new universal school-based positive education program (Boniwell & Ryan, 2009) that builds on cognitive-behavioral therapy and positive psychology concepts (e.g., resilience, post-traumatic growth) with the explicit goal of fostering emotional resilience and associated skills, as well as preventing depression. The program is delivered in 12 one-hour sessions across 3–4 months by local school teachers who have been trained extensively by professional psychologists and provided with all necessary teaching materials (i.e., teacher's guidebook with detailed curriculum for each session, DVDs with videos and presentation slides, props, and workbooks for participating children).

2.4. Measures

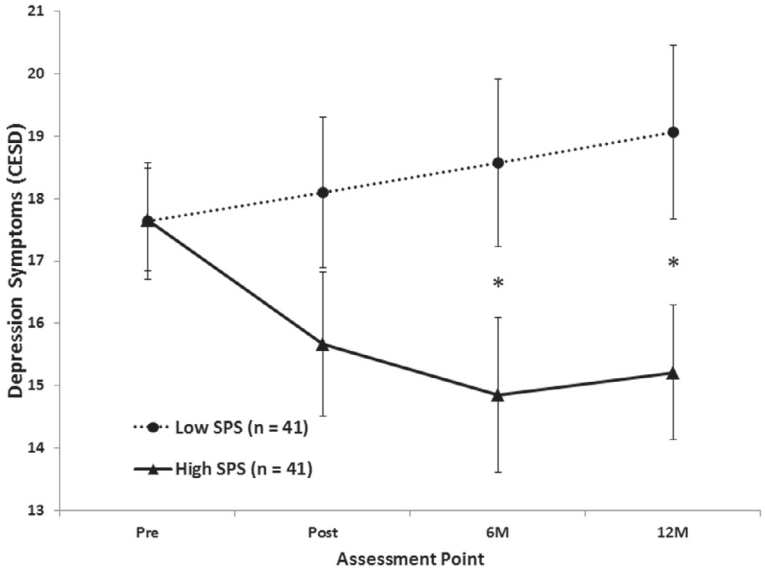
Children provided information regarding their gender, age in years, ethnicity of mother and father, number of persons living in their household, and education of their father at each assessment point. *Depression Symptoms* were assessed with the Center for Epidemiologic Studies Depression scale (CESD) (Radloff, 1977), a widely used 20-item measure inquiring about the presence of different depression symptoms in the past seven days (e.g., "I felt sad" and "I thought my life had been a failure") on a four-point scale ranging from "1 = rarely or none of the time" to "4 = all or most of the time". *Sensory-Processing Sensitivity* was measured with a 12-item child self-report version (Pluess et al., in preparation) of the Highly Sensitive Person scale (HSP) (Aron & Aron, 1997). Children rated how they generally feel on a seven-point scale from "1 = not at all" to "7 = extremely" (see Table 1 for all included items). Higher values reflect higher sensitivity. Internal consistency of the measure in the current sample was satisfactory (alpha = .74). For technical reasons associated with the logistics of data collection, SPS was measured at the post-rather than the pre-treatment assessment and only in the treatment cohort. For the analyses, SPS scores were corrected for concurrent negative affect, measured with the Positive And Negative Affect Scales (PANAS) (Watson, 1988), following recommendations of the authors of the original Highly Sensitive Person Scale (Aron & Aron, 1997). In order to achieve this, SPS scores were residualised in a regression model for the influence of negative affect. Residualised SPS scores correlated highly with the original scores ($r = .99$, $p < .01$).

Table 1
The 12 items of the Highly Sensitive Person Scale – Child Short form.

1	I notice when small things have changed in my environment
2	Loud noises make me feel uncomfortable
3	I love nice smells
4	I get nervous when I have to do a lot in little time
5	Some music can make me really happy
6	I am annoyed when people try to get me to do too many things at once
7	I don't like watching TV programs that have a lot of violence in them
8	I find it unpleasant to have a lot going on at once
9	I don't like it when things change in my life
10	I love nice tastes
11	I don't like loud noises
12	When someone observes me, I get nervous. This makes me perform worse than normal

2.5. Statistical analysis

The moderation of treatment efficacy as a function of SPS was tested longitudinally with a hierarchical linear model (growth curve analysis) across the four repeated measures *within* the treatment cohort only, which allowed for estimation of growth curves for all of the 166 children included in the treatment cohort regardless of missing data across the different assessments. In order to illustrate and interpret the results of the hierarchical linear model,



Note. SPS = Sensory-Processing Sensitivity;* $p < .05$. ** $p < .01$.

Fig. 2. Growth curve model-predicted depression scores of the treatment cohort for Sensory-Processing Sensitivity extreme groups (top and bottom 25%, $n = 41$ for each) across the four measuring points in order to illustrate growth curve model findings that emerged using the whole treatment cohort ($N = 166$).

extreme groups were created based on SPS scores (top and bottom 25%) and growth curves were plotted for these extreme groups on the basis of model predicted depression scores. Change in depression between pre assessment and 12 months follow-up assessment *within* each extreme group were tested with dependent *t*-tests. Differences *between* high and low SPS groups of the treatment cohort as well as *between* high/low SPS treatment groups and the complete control cohort at the 12 months follow-up assessment were investigated with independent sample *t*-tests (using growth curve model predicted depression scores for the treatment group in order to account for missing data). The level of significance was set at $\alpha = .05$. All statistical analyses were carried out using SPSS version 19 for Windows.

3. Results

According to univariate analyses of variance (ANOVA), depression and SPS did not differ as a function of child ethnicity or paternal education in either cohort. Similarly, bivariate correlations yielded no significant association between family size and depression or SPS. Consequently, ethnicity, family size and paternal education were not included as covariates in the analyses. Descriptive statistics and bivariate correlations of depression and SPS are reported in Table 1. Importantly, SPS was not associated with depression scores at pre and post assessment, suggesting that SPS measures assessed at post-treatment were not influenced by treatment effects.

In a hierarchical linear model that included both linear and quadratic slopes across the four depression assessments in the treatment cohort, SPS significantly predicted the depression intercept at the 12-months follow-up assessment ($B = -.18$, $p = .03$) as well as the linear change in depression scores over time ($B = -.08$, $p < .01$). However, there was no significant differences in depression scores between the treatment and control cohort at the 12-month follow-up assessment ($t_{(361)} = -1.64$, $p = .10$, $d = -.17$), a finding consistent with the original evaluation of the study (Pluess et al., submitted). In order to investigate the significant effects of SPS on the intercept centered at 12 months and the slope of depression, extreme groups (bottom and top 25% of the treatment cohort based on the original SPS scores) were created and model-predicted depression scores for both extreme groups plotted across the four measuring points (see Fig. 2). The top SPS group ($M = 67.90$, $SD = 6.16$) had significantly higher SPS scores ($t_{(80)} = 18.62$, $p < .01$) than the bottom SPS group ($M = 40.80$, $SD = 6.99$). According to repeated *t*-tests *within* each extreme group between the pre-assessment and the 12-months follow-up assessment, the change within the low SPS group was not significant ($t_{(40)} = 1.45$, $p = .16$, $d = .19$) whereas it was highly significant in the high SPS group ($t_{(40)} = -2.95$, $p < .01$, $d = -.40$). According to *t*-tests *between* the two groups, the high SPS group did not differ from the low SPS group at pre and post assessment, but had significantly lower depression at the 6-months ($t_{(80)} = -2.04$, $p < .05$) and the 12-months assessment ($t_{(80)} = -2.18$, $p = .03$)[1]. Comparing the 12-months assessment depression scores of both high and low SPS treatment groups with the complete control cohort revealed that the low SPS group did not differ from the control cohort ($t_{(236)} = .41$, $p = .68$, $d = .07$), whereas the high SPS group had significantly lower depression scores ($t_{(236)} = -2.08$, $p = .04$, $d = -.39$). These findings are illustrated in Fig. 3.

4. Discussion

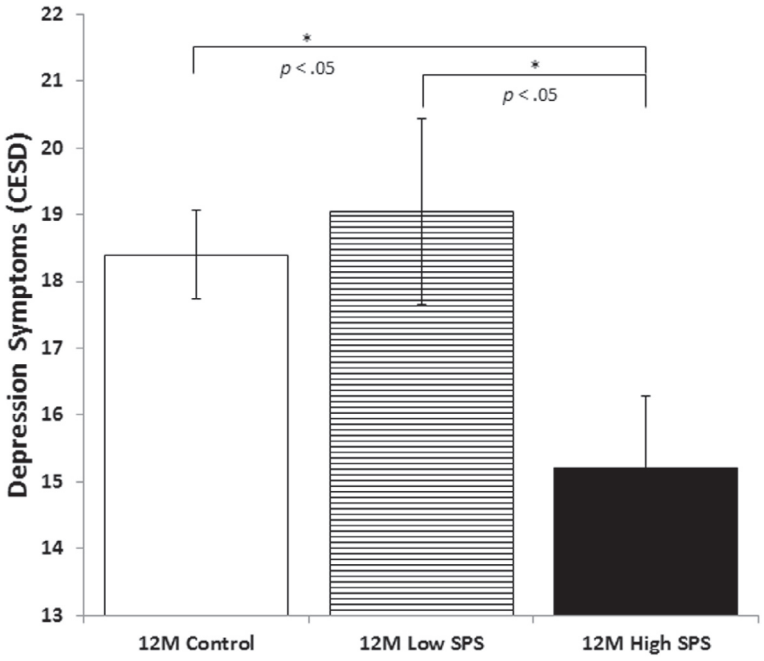
Consistent with the hypothesis, SPS significantly predicted treatment response to a depression prevention program in a sample of girls from an economically deprived background. The intervention had a substantial positive effect in girls scoring high on SPS but was not effective at all in girls scoring low on the same measure. Although low and high SPS girls did not differ in their initial depression scores at baseline, high SPS girls had significantly lower depression scores at the 6- and 12-months follow-up assessments.

[1] According to these follow-up analyses SPS extreme groups differ significantly at 6 and 12 months based on model predicted depression scores. However, bivariate correlations in Table 2 suggest that there was no significant association between SPS and depression at 6 and 12 months. The reason for this contradiction is that bivariate correlations were based on complete data only ($n = 144$ for 6 months, $n = 113$ for 12 months) whereas the growth curve model and follow-up analyses are based on all cases using model predicted depression scores ($n = 166$ for growth curves, $n = 82$ for extreme groups).

Table 2
Descriptive statistics and unadjusted associations for outcome variables of the control ($N = 197$) and treatment cohort ($N = 113–166$).

	Variables	Mean value	Standard deviation	Sample size	1	2	3	4
	Depression 12M (CC)	18.40	9.27	197				
1	Depression Pre (TC)	17.06	7.77	141	–			
2	Depression Post (TC)	16.44	9.50	166	**.53****	–		
3	Depression 6M (TC)	15.49	9.46	144	**.36****	**.69****	–	
4	Depression 12M (TC)	16.90	10.46	113	**.24***	**.44****	**.61****	–
5	Sensory-Processing Sensitivity (TC)	54.25	11.00	166	.13	−.04	−.12	−.13

Note. CC = control cohort, TC = treatment cohort, statistically significant correlations are marked bold.
* $p < .05$.
** $p < .01$.



Note. SPS = Sensory-Processing Sensitivity;*$p < .05$. **$p < .01$.

Fig. 3. Depression mean scores of the complete control cohort ($N = 197$) and growth curve model-predicted depression scores for both Sensory-Processing Sensitivity extreme groups (top and bottom 25%, $n = 41$ for each) at the 12-months follow-up assessment in order to illustrate growth curve model findings that emerged across the whole sample ($N = 363$).

Furthermore, when comparing the high and low SPS groups to the control cohort at the 12-months follow-up assessment, the high SPS group had significantly lower depression scores than the control cohort, whereas the low SPS group did not differ from the control cohort at all.

Importantly, whereas the treatment effect *across the whole sample* (derived from comparison between treatment and control cohort) was not significant at the 12-month follow-up assessment, a subgroup of children, those scoring high on SPS, appeared, in fact, to have significantly lower depression scores at 12-month follow-up compared to the control cohort, suggesting that the intervention was indeed effective but only for a subsample of the girls. Interestingly, the positive treatment effects in the high SPS group emerged only in the follow-up assessments, suggesting that depression scores of the high SPS group declined progressively over time. Given that SPS is characterized not only by high sensitivity to environmental influences but also deeper processing of such influences (Aron & Aron, 1997) one possible reason why girls scoring high on SPS benefitted more from the intervention over time—and continued to do so even many months after the intervention ended—is that they processed the content of the intervention more deeply which may have led to better internalization and, consequently, continued application of the acquired cognitive-behavioral coping strategies.

The primary assumption why individuals scoring high on SPS tend to be more responsive to environmental influences, including psychological intervention, is that they may be characterized by a more sensitive central nervous system which enables them to process environmental stimuli more deeply (Aron & Aron, 1997; Aron, Aron, & Jagiellowicz, 2012). A recent imaging study provides empirical evidence for this claim, reporting a significant association between SPS and greater activity in brain regions involved in visual processing (Jagiellowicz et al., 2011). Another study points towards a potential genetic basis of SPS involving a number of genes in the dopaminergic and serotonergic systems (Chen et al., 2011). Hence, the greater treatment response of girls scoring high on SPS may be due to genetic characteristics that contribute to brain activities related to deeper processing of environmental influences, greater ability to direct attention heightened, and reward sensitivity (Pluess & Belsky, 2013). At this point, however, these assumptions remain speculative at best and more work is required to elucidate the exact mechanisms underlying the heightened environmental sensitivity associated with SPS.

Nevertheless, the current study provides the first empirical evidence that SPS predicts treatment response consistent with the *Vantage Sensitivity* framework (Pluess & Belsky, 2013). Future studies may want to test other potential *Vantage Sensitivity* factors (e.g., other personality traits, but also physiological and genetic factors)

as SPS may not necessarily be the only or the best measure to predict *Vantage Sensitivity* in the context of psychological interventions. Furthermore, the findings of the current study will have to be replicated across different samples and across a range of different interventions before routine measurement of SPS in clinical settings can be recommended as a means of predicting treatment response.

The strengths of this study include the recruitment of a sample most at risk for the development of depression (i.e., girls, deprived neighborhood), a two-cohort treatment/control design which ensured that there was no bias for inclusion to the treatment or control group, and the comparison of control and treatment cohorts at the 12-month follow-up assessment with a focus on long-term rather than short-term effects. However, findings have to be considered in light of several methodological limitations. Firstly, children were not randomly allocated into treatment and control groups which limits causal interpretation of the findings. Secondly, all measures were based on child self-report. Thirdly, children in the control cohort were assessed only once. Fourthly, the evaluation did not control for important covariates (e.g., socio-economic status of family, parenting quality, psychopathology of parents). And finally, SPS in the treatment cohort was assessed at post treatment rather than at pretreatment. It has to be emphasized in this regard, however, that according to bivariate correlations SPS was not associated with depression scores at pre and post assessment, suggesting that SPS scores were not influenced by the intervention.

In conclusion, the current study provides first evidence for *Vantage Sensitivity* as a function of SPS regarding treatment response to a depression prevention intervention in a Western youth population most at risk for mental health problems. According to the current analysis positive treatment effects were confined to a subsample of children characterized by high SPS. Treatment effects in this subsample were much stronger than the average effect across the whole sample, whereas girls in the low SPS group did not benefit from the intervention at all. Prediction of treatment response with a brief self-report personality measure such as the one used in this study may be helpful for the selection and specific indication of psychological intervention on an individual personalized level.

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