



מרכז ארצי לבחינות ולהערכה (ע"ר)
NATIONAL INSTITUTE FOR TESTING & EVALUATION
المركز القطري للامتحانات والتقييم
מיסודן של האוניברסיטאות בישראל

Mapping Statistical Suppression Situations Using Structural Equation Modeling

Research Report

RR
21-02

April 2021

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RR-21-02

ISBN:978-965-502-219-3

Mapping Statistical Suppression Situations Using Structural Equation Modeling¹

Golan Shahar

Nirit Soffer-Dudek

Joseph Tzelgov

Department of Psychology, Ben-Gurion University of the Negev

Anat Ben-Simon

National Institute of Testing and Evaluation (NITE)

April 2021

¹ The study was supported by NITE Research Foundation

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Abstract

Statistical suppression situations play a major role in the (mis-)understanding of interrelated variables belonging to certain systems, or universes. These situations pertain to a pattern whereby the X-Y association changes dramatically when Variable S (the suppressor) is taken into account. Once deemed “statistical noise”, suppression situations are now considered as a phenomenon crucial to the way variables in science in general – and in behavioral and health sciences in particular – are conceptualized and measured, hence they are conducive to both basic and applied science.

The aim of this investigation was to demonstrate the feasibility ("proof of concept") and utility (clinical validity) of utilizing a bivariate SEM approach for detecting suppression situations. To examine this approach, we utilized two data sets from BGU – on dissociation and heroic self-representations and one from NITE – on attention difficulties and anxiety. For each data set, a clear suppressor was identified and tested using SEM. Findings showed that our approach was successfully demonstrated for dissociation, partly demonstrated for heroic self-representations, and was not demonstrated for attention and anxiety.

From a psychometric point of view, our approach cautions against straightforward application of suppression situation to causal analysis whether done via multiple regression or via SEM. Our findings suggest that, prior to modeling causal (directional) relationships that include suppression effects, researchers should first make sure that the suppressor is indeed univariate rather than bivariate. If the latter is the case, that causality is irrelevant.

Background

Statistical suppression situations play a major role in the (mis-)understanding of interrelated variables belonging to certain systems, or universes (Horst, 1941; Meehl, 1945; Simpson, 1951; Tzelgov and Henik, 1991). These situations pertain to a pattern whereby the X-Y association changes dramatically (increases, decreases, changes from a negative-to-positive-direction or vice versa) when Variable S (the suppressor) is taken into account. Once deemed “statistical noise”, suppression situations are now considered as a phenomenon crucial to the way variables in science in general – and in behavioral and health sciences in particular – are conceptualized and measured, hence they are conducive to both basic and applied science (e.g., Gayord-Harden, Cunningham, Holmbeck, & Grant, 2010; Shahar & Priel, 2002, 2003). This realization has recently permeated psychological research, which often provides inconsistent findings concerning the X-Y associations, with evidence for specific S variables attenuating these associations in meaningful ways.

The purpose of this study is to espouse a Structural Equation Modeling approach (SEM) in order to identify and map suppression situations that have not been examined thus far. SEM – constituting a unique amalgamation of factor analysis, general linear modeling, and goodness of fit procedures -- is highly advantageous in terms of partitioning variance facets of highly complex constructs such as depression, suicidality, stress, risk and resilience.

The gist of our approach is to focus on SEM to study suppression situation based on partial correlations. Consider the following two Figures:

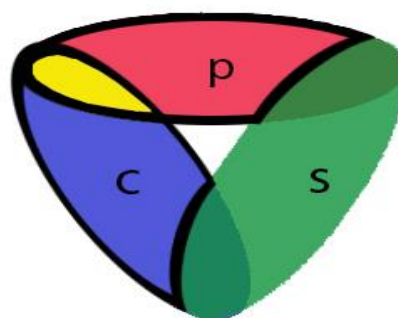


Figure 1: A Venn diagram suggesting suppression in a partial correlation context.

Variables **C** and **P** are correlated. Variable **S** is a suppressor. The yellow segment represents the variance common to **C** and **P**. The proportion of the yellow part shared by **C** and **P** is greater in the presence of **S** and in **S**'s absence. The crux of this figure is that, unlike previous research, **S** operate by neutralizing variance in both variables, i.e., **C** and **P**.

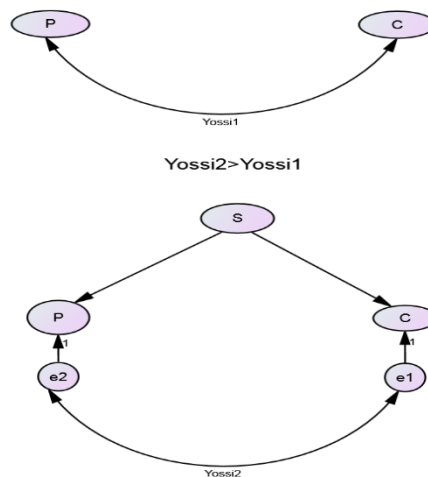


Figure 2: A SEM test for the Vann Diagram in Figure 1.

Two correlations are compared in Figure 2. The zero-order correlation between **C** and **P**, "**Yossi1**", assessed as latent variables, is compared to the partial correlation between the disturbances of **C** and **P**, i.e., the part of the variance in each of these variables that is unrelated to **S**, the suppressor, "**Yossi2**". To the extent that "**Yossi2**" > "**Yossi1**", then **S** is an effective suppressor.

The present research

We conducted a secondary SEM analysis of data collected at BGU and NITE. From BGU, we utilized data on psychological dissociation (**STUDY 1**) and Heroic Self-Representations (**STUDY 2**). From NITE (**STUDY 3**), we utilized data on computerized tests of attention deficits, self-report questionnaire of Attention Deficits and Hyperactivity Disorder (ADHD), and self-reported items assessing anxiety. In each of these studies, we laid out clear hypotheses as to how the pattern presented in Figures 1 and 2 should look like, and tested it via SEM.

STUDY 1: PSYCHOLOGICAL DISSOCIATION AND "FLOW"

This study focused on the understanding of psychological dissociation and its link with a psychological construct named "flow" (Nakamura & Csikszentmihalyi, 2014). Flow pertains to the inclination to be immersed in a rewarding activity, where there is a balance between difficulty and skill. Both dissociation and flow are tendencies for experiencing immersive states of consciousness.

Soffer-Dudek and students have shown that flow is a multi-facets construct, and that while some facets are connected to dissociation, other are not (Zadik, Bregman-Hai, & Soffer-Dudek, under review). Specifically, the "flow" facet that is related to dissociation pertains to "autotelic experience", which is enjoyable action taken for its own sake, and merging action with awareness (i.e., one becomes one's action). Conversely, mental states inherent in flow, such as concentration and a sense of control, are opposite to dissociation. We used this complexity to test our approach to suppression situations, presented in Figures 1 and 2.

Method

Participants

Three-hundred and fourteen undergraduate students from Ben-Gurion University of the Negev enrolled for a study on: "Dissociation, attention, risk, and resilience", completing questionnaires including trait flow, dissociation, and SE. Additional measures were administered, beyond the scope of the present investigation, described elsewhere (Soffer-Dudek, 2019). Questionnaire order was counterbalanced. Eleven participants were excluded from the final sample due to either substantial missing data (7 participants), or very short completion time (less than 15 minutes in total for all questionnaires; 4 participants). Thus, the final sample comprised 303 participants (225 women, 78 men; aged 18–28, $M = 23.53$, $SD = 1.39$). Of the full sample, 215 participated in exchange for course credit and 88 in exchange for monetary reimbursement of 50 NIS (~\$14). Independent samples *t*-tests indicated no significant differences between them on any of the study variables.

Measures

Dissociation is measured via the Dissociative Experiences Scale (DES, Carlson & Putnam, 1993), assessing a range of 28 dissociative phenomena on an 11-point Likert

scale, and producing three subscale scores: dissociative absorption, dissociative amnesia, and depersonalization-derealization.

Flow was assessed using the Dispositional Flow Scale-2 (*DFS-2*; Jackson & Eklund, 2002), a 36-item self-report inventory with a scale ranging from 1 (never) to 5 (always). Nine dimensions of flow are assessed, namely: challenge-skills balance, clear goals, unambiguous feedback, total concentration on the task at hand, sense of control, loss of self-consciousness, merging action and awareness, transformation of time, and autotelic experience.

Three latent variables were defined: DISSOCIATION (assessed via the absorption, amnesia, and depersonalization-derealization subscales of the DES), FLOW (autotelic experience and merging action and awareness, *DFS-2*), and FOCUS (sense of control and concentration, *DFS-2*).

Results

Table 1 presents the correlations among the three putative variables: DISSOCIATION, FLOW, and FOCUS. Note that these are "disattenuated correlations", namely, correlations among latent variables. As such, they are measured without measurement error.

TABLE 1: DISATTENUATED CORRELATION AMONG SAMPLE 1's VARIABLES.

	DISSOCIATION	FLOW	FOCUS
DISSOCIATION	1.00	---	---
FLOW	.10 ^{ns}	1.00	---
FOCUS	-.41***	.64***	1.00

Note: ^{ns} Non-significant; *** $p < .001$.

Note that the correlation between DISSOCIATION and FLOW is small and non-significant, $r = .10$. The covariance pertaining to this correlation is 0.46. In contrast, strong ($r_s > .4$) and statistically significant ($p < .001$) correlations were evinced between DISSOCIATION and FOCUS and FLOW and FOCUS (COVs: -3.71 and .13, respectively).

Next, in Figure 3 we estimated a model in which FOCUS predicts DISSOCIATION and FLOW. The disturbances of the two latter variables were allowed to covary, representing the zero-order correlation between DISSOCIATION and FLOW appearing in Table 1. However, we fixed the covariance between this disturbance to 0.46, the same covariance revealed in the correlational analysis (pertaining to $r = .10$). Such a constraint imposed on the model essentially forbids the suppression, FOCUS, from operating. The fit of this model to the data was inconclusive, which is expected given our hypothesis that FOCUS is indeed an effective suppressor: $\chi^2_{[df=12]} = 32.06$, CFI = .97, TLI = .95, RMSEA .07. The correlation between the disturbances of DISSOCIATION and FLOW (emanating from fixing the equivalent covariance to 0.46) was $r = .17$, very close to the one presented in Table 1. As well, the standardized effects (β) of FOCUS on DISSOCIATION and FLOW were -.39 and .59, which are very close to the equivalent correlations presented in Table 1.

In Figure 4 we present a relaxed model, in which the suppressor, FOCUS, is active. A dramatic change in the association between DISSOCIATION and FLOW is evinced: The correlation is now $r = .52$, about five times stronger than the correlation presented in Table 1, and about three times stronger than the one appearing in Figure 3. The effects of FOCUS on DISSOCIATION and FLOW are similar to the equivalent correlations appearing in Table 1: -.41 and .65, respectively. The fit of this model is unequivocally excellent: $\chi^2_{[df=11]} = 21.55$, CFI = .98, TLI = .97, RMSEA = .05). Even more importantly, the relaxed model (in Figure 4) is formally superior to the constrained one (in Figure 3): Chi-Square Difference Test $_{[df=1]} = 10.51$, $p = .001$).

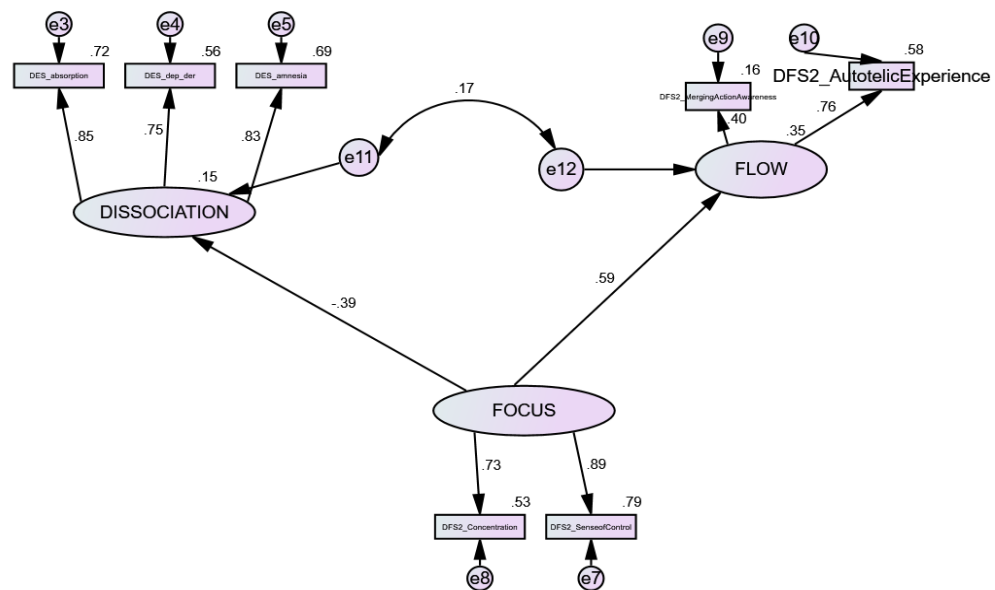


Figure 3: SEM model in which the covariance connecting DISSOCIATION and FLOW is fixed at the level of the covariance in the absence of the suppression (FOCUS).

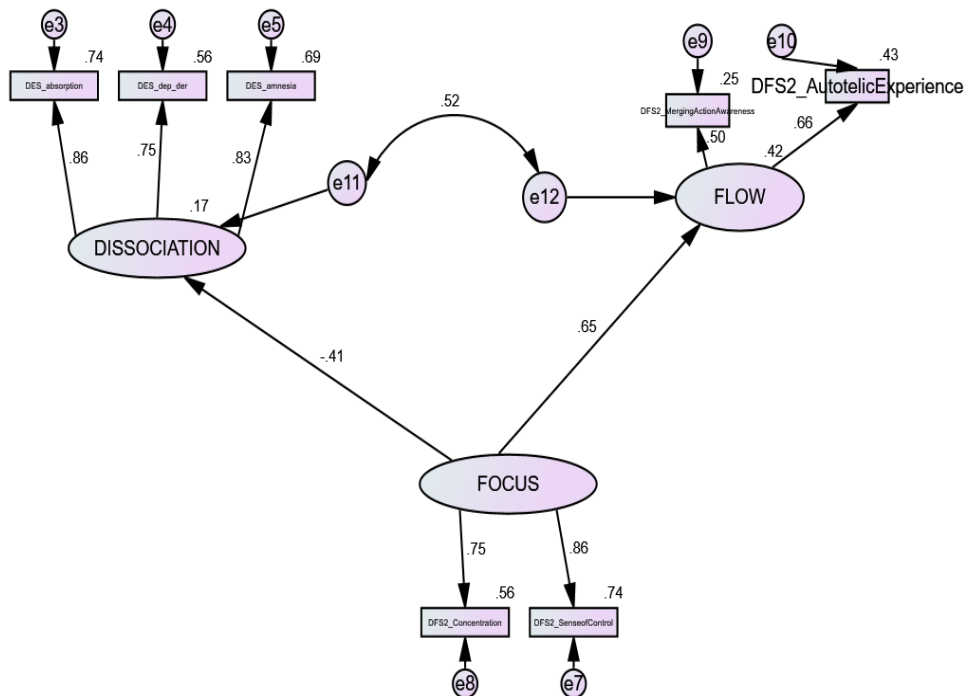


Figure 4: A relaxed SEM (the suppression – FOCUS – is active).

Discussion

These analyses are highly consistent with our novel conceptualization of statistical suppression situation, whereby the suppressor may neutralize irrelevant variance in each of the two variables involved. Specifically, in this case the suppressor, FOCUS, neutralized variance in both DISSOCIATION and FLOW. Without such neutralization, the correlation between the latter two variables was small and non-significant. With the suppression included, the correlation has markedly increased and was actually very strong.

Within the universe of altered consciousness, these findings shed a new light on dissociation, as assessed by the DES. Namely, when the variance in DES related to (lack of) focus is partialled out, DES-dissociation is strongly linked with flow. Because flow is considered a resilience factor (e.g., Asakawa, 2010). This suggests that DES-dissociation, a variable pertaining to pathology, may perhaps also include an element of resilience. This conclusion is compatible with Shahar, Elad-Strenger, and Henrich's (2012) novel perspective on risk and resilience, according to which each psychological factor includes an element of both.

STUDY 2: HEROIC SELF-REPRESENTATIONS, SELF-CRITICISM, AND GENERALIZED SELF-EFFICACY.

Shahar and colleagues (Shahar, 2013; Israeli, Itamar, & Shahar, 2018; Itamar & Shahar, 2014) identified a novel, stress-related personality trait titled "heroic self-representation", or HERS. HERS pertains to individuals' tendency to view their self and their world in heroic terms. More specifically, HERS rests on three aspects: Self-as-conqueror (SAC; the tendency to view oneself as conquering formidable challenges), self-as-savior (SAS; the tendency to view oneself as saving others) and heroic-self-representation (HI; the tendency to identify with heroic figures). In identifying this trait, Shahar and colleagues have drawn from cognitive, psychodynamic, and existential conceptualization, as well as from social-constructivist theories highlighting the impact of cultural ethos on cognitions and the self (see in particular Shahar, 2013; Israeli et al., 2018).

According to Shahar and colleagues, HERS embodies the tension between psychological risk and resilience: It includes elements of both. Thus, HERS allows individuals to feel empowered under stress, but also exhaust these individuals, leading to their decompensation. To test these hypotheses, Shahar and colleagues developed the Shahar Heroic Self Scale (SHERS; Shahar, 2013), a 9-item measure assessing the aforementioned three HERS aspects. Each aspect is assessed via three items, tapping cognition, emotion, and motivation for heroism. Psychometric properties of the SHERS have shown to be sound. As hypothesized, HERS aspects are associated with both risk and resilience, albeit differentially: SAC is mostly associated with resilience, SAS with both, and HI is mostly associated with risk.

A close examination of the findings reported by Shahar and colleagues suggests an interesting suppression situation involving HERS, self-criticism, and generalized self-efficacy. Self-criticism, defined as the tendency to embrace increasingly high self-standards and to adopt a punitive self-stance once these standards are not met, has been shown over the last three decades as a formidable dimension of vulnerability to a host of psychopathologies (Shahar, 2015). Self-efficacy pertains to the belief in one's capabilities to exercise control over one's life (Bandura, 1997). The construct epitomes resilience (Benight & Bandura, 2004). Individuals with high self-efficacy approach difficult tasks with confidence in their own capabilities, visualize success scenarios, and maintain strong commitment to seeing tasks through (Bandura, 1997). Whereas

Bandura referred to self-efficacy as domain specific (Bandura, 1977), later studies present it as a global construct pertaining to a motivational trait (Schwarzer & Jerusalem, 1995; Shelton, 1990) and that general self-efficacy may be used when the context is less specific or the human behavior is widely-ranged. In extant HERS research, positive associations were found between HERS (particularly SAC) and generalized self-efficacy, whereas the associations between HERS and self-criticism were weak and inconclusive. Self-criticism and generalized self-efficacy are known to be inversely related (Shahar, 2015).

Herein we hypothesize that there actually is a positively-directed association between HERS and self-criticism, but that this association is concealed behind the suppressing effect of generalized self-efficacy: Because the latter captures the inverse of self-criticism and the converse of HERS, the association between HERS and self-criticism are obscured. Why is this important? Because, to the extent that HERS does involved harsh self-criticism, the tendency of heroic figures to suffer from depression and related psychopathology is illuminated (see Shahar, 2013, for a conceptual extension of this hypothesis).

We examined this possibility by using a hitherto unpublished data in which HERS, self-criticism, and generalized self-efficacy played only a secondary role. The data was collected by Maayan Menahem, a doctoral student of Prof. Shahar and Prof. Galia Avidan from BGU, and were aimed to shed light on the links between stress, social support, and perception of emotional facial expression. The data is conducive to the present investigation because, in addition to including measures of the aforementioned three traits, it is also longitudinal: Three assessment waves were conducted. In all assessment waves, a clear pattern was identified consistent with the suppression pattern presented in Figures 1 and 2. However, the strongest pattern was shown for Wave 2. Hence, we report findings from this wave.

Method

Participants

Participants were freshmen psychology students at the Department of Psychology of BGU. Two samples were collapsed. In Sample 1 (2015/16), 74 females and 25 males ($N = 99$) participated. In Sample 2 (2016/17), 35 females and 77 males ($N = 112$) participated. No differences were revealed across samples with respect to the

study variables. When the sampled collapsed, the N was 211 at Wave 1, 203 at Wave 2, and 200 at Wave 3. The mean age was 23.59 (SD = 1.32).

Measures

General Self-Efficacy Scale (GSE)

The GSE (Schwarzer & Jerusalem, 1995) is a 10-item scale assessing the belief that one's actions can produce successful outcomes (e.g., "Thanks to my resourcefulness, I know how to handle unforeseen situations"). Items are rated on a 4-point Likert scale ($\alpha = .81$). Because of the unidimensional nature of this construct, we assessed it as a manifest variable.

Heroic self-representations (HERS)

The SHERS is a self-report questionnaire comprised of nine items, with three items for each component: self-as-savior (e.g., "I have a profound need for saving people from their plight"), self-as-conqueror (e.g., "I have a profound need to conquer difficult challenges"), and heroic identification (e.g., "It is important for me to view myself as a hero"). Participants were instructed to read each statement and rate their agreement with each, in respect to their personality, on a 6-point Likert scale (1 - strongly disagree, 6 - strongly agree). The internal consistency coefficients (Cronbach's α) of the SHERS variables in the current study were: self-as-savior = .85, self-as-conqueror = .91, and heroic identification = .74. For these analyses, HERS was assessed as a latent variable, indicated via SAC, SAS, and HI.

Self-criticism

Self-criticism was measured by the Depressive Experiences Questionnaire (DEQ; Blatt, D'Afflitti, & Quinlan, 1976). The DEQ is a sixty-six-item scale devised to evaluate patterns of experiences that cause predisposition to depressive states, and is therefore appropriate for use with a nonclinical population. Rudich, Lerman, Gurevich, Weksler, and Shahar (2008) identified six DEQ items that have straightforward content validity in terms of measuring self-criticism. Using several data sets, Rudich et al. (2008) demonstrated exceedingly strong correlations between the six-item measure and the original self-criticism factor of the DEQ ($r_s > .80$) and internal consistency (Cronbach's $\alpha = .73$) as well as statistically significant correlations between the six-item measure and depression and related constructs, correlations which are equivalent in magnitude to the correlations between the original self-criticism factor of the DEQ and depression

and related constructs. Because the issue of unidimensionality in this measure is unclear, we calculated three random parcels of two items each, and used them as manifest indicators of a self-criticism latent variable (Little, Cunningham, Shahar, & Widaman, 2002).

Results

Table 2 presents the correlations among the three putative variables: HERS, Self-criticism, and Generalized Self-Efficacy. Note, that the correlation between HERS and self-criticism is "disattenuated".

TABLE 2: CORRELATION AMONG SAMPLE 2's VARIABLES.

	HERS	Self-Criticism	GSE
HERS	1.00	---	---
Self-criticism	.27*	1.00	---
GSE	.31*	-.27*	1.00

Note: ^{ns} Non-significant; * $p < .05$.

The correlation between HERS and Self-criticism was $r = .27$, corresponding to a covariance of 0.18. Repeated the analytic procedure described at STUDY 1, we fixed the correlation between the disturbances of HERS and Self-criticism to be equal to this covariance. The fit of this model to the data was good: $\chi^2_{[df=8]} = 6.39$, $p = .60$, CFI = 1.00, TLI = 1.01, RMSEA .00. The correlation between the disturbances of HERS and Self-criticism (emanating from fixing the equivalent covariance to 0.18) was $r = .47$, i.e., higher than the correlation presented in Table 2. As well, the standardized effects (β) of GSE on HERS and Self-criticism were .42 and -.28, reasonably close to the one presented in Table 2. The fit of the relaxed model, allowing suppression, was somewhat better than that of the fixed model, particularly in terms of the χ^2 test: $\chi^2_{[df=8]} = 4.70$, $p = .60$, CFI = 1.00, TLI = 1.02, RMSEA .00. However, the differences between the two models, tested via the χ^2 difference test (DF=1), did not reach statistical significance: 1.69, $p = .19$. However, the correlation between the disturbances of HERS and Self-criticism was .55, which is 17% (!) stronger than the equivalent correlation in the fixed

model: $.55 - .47 = .08$; $.08 / .47 = .17$. Generalized self-efficacy predicted elevated levels of HERS ($\beta = .41, p < .01$) and lower levels of self-criticism ($\beta = -.27, p < .01$).

Discussion

The pattern showed for heroic self-representation, self-criticism, and generalized self-efficacy in this study parallels the one showed for dissociation, flow, and focus in STUDY 1. As in the case of focus in STUDY 1, a third variable, generalized self-efficacy, served as a suppressor of the association between heroic self-representation and self-criticism. Note, however, that the suppression pattern was less dramatic in magnitude, leading to a non-significant value of the χ^2 difference test (DF=1), did not reach statistical significance. We believe that the reasons are obvious: the correlations between dissociation, flow and focus are weaker than the ones involving heroic self-representations, self-criticism and generalized self-efficacy, arguably because the latter three are explicit self-concept variables.

Nevertheless, an increase of 17% of the association between heroic self-representation and self-criticism in the presence of the suppressor, generalized self-efficacy, is far from being trivial. From a conceptual point of view, it may be important. Thus, there is a surge of research now days on heroism (Efthimiou & Allison, 2018), attesting to the relevance of this construct to understanding leadership, organization and political behavior, and psychopathology. The results reported here suggest that the risk-resilience dialectics, described by Shahar, Elad-Strenger, and Hernich (2012), which pertains to constructs imbuing both risk and resilience, is endemic to heroic self-representations, illuminating why heroic figures and heroes-to-be suffer: It is because they are likely to be self-critical, self-criticism being a formidable dimension of vulnerability (Shahar, 2015).

STUDY 3: COGNITIVE AND SELF-REPORT MEASURES OF ATTENTION DIFFICULTIES, AND ANXIETY.

Statistical suppression could help disentangle the complex pattern of associations between behavioral and cognitive processes in Attention and Hyperactivity Deficit Disorder (ADHD). Behavioral processes are usually measured via self-report scales, whereas cognitive processes are assessed via various types of Continued Performance Tests (CPTs), which consists of computer tasks. Research often indicates low correlations between the two types of measures (Ben-Simon & Inbar-Weiss, 2013). Such surprising pattern may be explained by the overlap between these measure and anxiety. Specifically, anxiety may enhance cognitive performance, because the test-taker may wish to "get it right". This will lead to a faster reaction time, also indicating the absence of attention difficulties. On the other hand, anxiety is known to be positively associated with self-report measures of attention difficulties (e.g., Schatz & Rostain, 2006). Thus, in the presence of anxiety, the weak correlation between cognitive and self-reported measures of attention difficulties should disappear, paving the way to a strong, positively directed, correlation.

NITE's database includes record of a vast number of applicants to, and students in, higher education who applied for learning disability and ADHD diagnosis. All students took the full MATAL test-battery including two computerized cognitive tests of attention problems and a self-report questionnaire of ADHD which includes items tapping both ADHD and anxiety symptoms. We used a sub-sample of this data to examine the hypothetical suppressor role of anxiety in the link between cognitive and self-report measures of attention problems.

Method

Participants

Database includes records of 2,441 applicants to, and students in, higher education who applied for learning disability and ADHD diagnosis in three diagnostic centers ($M_{age} = 23.86$, $SD = 3.05$, 50% females). All students took the full MATAL test-battery including two CPT type computerized cognitive tests of attention problems and a self-report questionnaire of ADHD which includes items tapping both ADHD and anxiety symptoms. Performance on the MATAL test suggested that 1,504 (63%) participants showed signs ADHD.

Measures

Cognitive measures of attention difficulties.

CPT-MATAL

This measure is based on the work of focusing on sustained attention (Tsal, Shalev, & Mevorach, 2005). The test is comprised of 420 visual stimuli presented on a computer screen, arranged in four blocks. Each stimulus is defined by two dimensions: shape and color. Participants are required to press a keyboard when the target dimension is presented, and to refrain from pressing when it is not. Attention deficits are assessed as a function of omission and commission errors, as well as by Reaction Time and its variability. Internal and test-retest variability, and convergent and discriminant validity have been established by NITE (Ben-Simon & Inbar-Weiss, 2013; Ben-Simon, Inbar-Weiss, Barneron & Polatchek (2015).

ANT

The ANT is a Hebrew adaptation of a task based on Posner's work on attention (Fan et al., 2002; Posner & Petersen, 1990). It assesses sustained, alerting, orienting, and executive attention. The test comprises 288 stimuli divided by three blocks, presented on a computer screen. A target stimulus is presented in the middle, above, or below a fixation point, and consists of arrows directed to either left or right. Participants are required to the direction of the target stimulus. 12 Priming cues appear prior to some of the stimuli. Attention deficits are assessed as a function of accuracy, RT, and executive, alerting, and orienting of attention. Internal and test-retest variability, and convergent and discriminant validity have been established by NITE (Ben-Simon & Inbar-Weiss, 2013). Here we focus on the accuracy, RT, and executive subscales (A. Ben-Simon, personal communication, December 11, 2018).

Behavioral ADHD symptoms

Behavioral ADHD symptoms were assessed via an 89-item self-report questionnaire developed at NITE, tapping attention and impulsivity & hyperactivity symptoms in childhood and adulthood. The items were developed based on the attention disorder dimensions described at the DSM-IV-TR, and reliability and validity were established by NITE (Ben-Simon & Inbar-Weiss, 2013). The measure provides an estimate of attention and impulsivity aspects in childhood (22 and 17 items, respectively) and adulthood (26 and 17 items, respectively).

Anxiety

An anxious distress measure was computed based on the likelihood scale of the above self-report measure. This likelihood scale is comprised of items aimed at assessing either the validity of participants' response style or their psychiatric distress. Three of these items clearly assess anxious distress: indecisiveness, nightmares, and perfectionism. Therefore, we used these items as indicators of anxiety.

Results

Already in the measurement model stage, we encountered serious obstacles for the construction of latent variables of cognitive attention difficulties and anxiety. For cognitive attention difficulties, the multitude of indicators yielded negative variances, rendering the model solution inadmissible. For the anxiety measures, did not load coherently on a single latent variable. Exploratory SEM analyses eventually succeeded in finding a combination of variables that could be fitted, although, as reported below, no suppression effects were identified.

In our exploratory SEMs, we separated the CPT and ANT variables and conducted analyses with each separately. The CPT latent variable was indicated by the omission and commission (Blocks 3 & 4) indicators. The ANT latent variable was indicated by executive control, RT mean, and accuracy. As for the anxiety variables, we used each of the three items – nightmares, perfectionism, indecisiveness --- separately. However, only the nightmare item was associated with the cognitive measures, hence we report findings with this variable only.

In Table 3 we report associations between latent CPT, behavioral/self-reported attention/impulsivity problems, and nightmares. Note that correlations involving either CPT or behavioral attention/impulsivity problems are "disattenuated".

Note two patterns: (1) Contrary to previous reports on low correlations between cognitive and behavioral measures of attention disorders, a strong correlation was revealed between CPT and the behavioral, self-reported attention/impulsivity problems. And, (2) contrary to our hypothesis, the correlation between nightmares and CPT was negatively, rather than positively, directed. Thus, nightmares, as an indicator of anxiety, was associated with derailing– rather than enhancing – the response to CPT. Because such derailment is consistent with a negative effect of anxiety on CPT, and because --- likewise – the correlation between nightmares and behavioral attention/impulsivity

problems also manifests a negative effect of anxiety (i.e., a positive correlation), statistical suppression could not ensue.

TABLE 3: CORRELATION AMONG LATENT CPT ATTENTION PROBLEMS, BEHAVIORAL ATTENTION/IMPULSIVITY PROBLEMS, AND NIGHTMARES.

	CPT	Behavioral	Nightmares
CPT	1.00	---	---
Behavioral	-.60 ***	1.00	---
Nightmares	-.21***	.31***	1.00

Note: *** $p < .001$.

Here is another demonstration with the ANT latent variable, indicated by three manifest variables: executive control, RT mean, and accuracy. Table 4 presents the correlations involving this variable, nightmares, and behavioral attention/impulsivity problems. Note that correlations involving either ANT or behavioral attention/impulsivity problems are "disattenuated".

TABLE 4: CORRELATION AMONG LATENT CPT ATTENTION PROBLEMS, BEHAVIORAL ATTENTION/IMPULSIVITY PROBLEMS, AND NIGHTMARES.

	ANT	Behavioral	Nightmares
ANT	1.00	---	---
Behavioral	-.32 ***	1.00	---
Nightmares	-.09***	.30***	1.00

Note: *** $p < .001$.

Note that the two patterns found for CPT are also present here: (1), a strong correlation between ANT and the behavioral, self-reported attention/impulsivity problems, albeit weaker than the one found for CPT. And, (2) The correlation between nightmares and ANT was negatively, rather than positively, directed. Here, too, the correlation was

much weaker than that found for CPT. In fact, it seems that this correlation was statistically significant by virtue of the huge sample size. Be that as it may, with this pattern, statistical suppression could not ensue.

Discussion

This data set was not conducive for our aim at examining bi-variate suppressors. This was mainly because our hypothesis, whereby anxiety – as a suppressor of the link between cognitive and behavioral/self-reported attention problems – would enhance – rather than derail – cognitive performance. The inverse was found with the nightmares indicator, essentially neutralizing our aim. It should be mentioned, however, that the measure of anxiety used here was far from being adequate (although we thought it would be). Hence, caution should be exercised in giving up on the prospect of identifying anxiety as a suppressor in this context.

Two interesting findings unrelated to suppression situations that did emerge from our analyses are; (1) that, contrary to prior reports, cognitive and behavioral measures of attention difficulties did overlap, and (2) nightmares were associated with both. In additional analyses unrelated to this project, we examine what is it in the cognitive measures that overlap with the behavioral ones, and we compare the cognitive and behavioral variables in terms of their ability to predict nightmares, moderated by social-demographic variables.

General Discussion

The aim of this investigation was to demonstrate the feasibility ("proof of concept") and utility (clinical validity) of utilizing a bivariate SEM approach for detecting suppression situations. The crux of our approach is three-fold:

1. Relying, when possible, on latent variables, which are measured without error and are hence more reliable than manifest ones.
2. Refraining to commit to a causal direction, i.e., enabling the suppression to "neutralize" variance in both X and Y.
3. Espousing the Chi-Square Difference Test as an arbiter of the effectivity of the putative bivariate suppressor.

To examine this approach, we utilized two data sets from BGU – on dissociation (Soffer-Dudek) and heroic self-representations (Shahar) – and one from NITE – on attention difficulties and anxiety. For each data set, a clear suppressor was identified and tested

using SEM. Findings were as follows: Our approach was successfully demonstrated for dissociation, partly demonstrated for heroic self-representations, and was not demonstration for attention and anxiety.

While the above pattern of results can be said to be "mixed", we view it as a clear success. Our approach is non-trivial, and has not been offered before. It enjoys clear advantages for basic clinical psychological science, as well as for clinical practice (see below). That this approach was successfully demonstrated in even a single data set is noteworthy. Moreover, that it was shown for dissociation, which is a serious clinical problem, is even more important. Lastly, the magnitude of the suppressor effect – shown or "focus" in the link between dissociation and flow – is targeting: In the presence of the suppressor, this link was three-times stronger than in the suppressor's absence.

From a basic psychological science point of view, our approach to identifying suppression situations is highly consistent with Shahar et al.'s (2012) quite radical reconceptualization of the risk/resilience field. Specifically, these authors question the unidimensionality of both risk and resilience constructs, arguing – based on theory, clinical wisdom, and a review of empirical research, that each of these constructs also includes elements of its inverse: Risk constructs include aspects of resilience, and vice versa. Our findings suggest that identifying bivariate suppressors enables the appreciation of the dialectics impacting both X and Y, rather than just X, as in Shahar's previous research (Shahar & Priel, 2002, 2003).

From a psychometric point of view, our approach caution against straightforward application of suppression situation to causal analysis (Davis, 1985), whether done via multiple regression (Tzelgov & Henik, 1991) or via SEM (Shahar & Priel, 2003). Our findings suggest that, prior to running ahead and modeling causal (directional) relationship that include suppression effects, the investigator should first make sure that the suppressor is indeed univariate (i.e., suppresses variance in only one of the variables) rather than being bivariate (i.e., suppressing variance in either, or both, variables). If the latter is the case, that causality is irrelevant.

Finally, from a clinical assessment point of view, bivariate suppressions should illuminate the sophisticated clinical use of instruments. For instance, one of the present authors (GS) works with dissociative patients in his clinic. Accordingly, GS administers

the DES routinely for incoming patients in his treatment, when he suspects dissociative symptoms. Based on the present findings, GS will now appraise more critically elevated levels of DES-dissociation reported by patients in his clinic, examining whether these actually reflect high flow rather than dissociative pathology, and measuring psychological control as a way to examine the extent to which – for these patients – the dissociation-flow connection is indeed operative. Further such clinical usages should be employed in other realms of psychopathology (e.g., depression, anxiety, somatization).

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RR-21-02
April 2021