





Influences Of Different Dimensions Of Academic Self-Concept On Students' Cardiac Recovery After Giving A Stressful Presentation

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Purpose: Giving a presentation in a seminar is a strenuous academic situation. To meet such a challenge adequately, individuals not only have to activate their mental and physical resources, but they also have to disengage from the task and recover once the challenge has been met. How students experience these situations depends in part on how they recover from the stress, and this has putative impact on their longer-term academic well-being.

Methods: In a sample of 68 university students, the present study investigated the impact of four dimensions of students' academic self-concept on how efficiently students recovered after a challenging presentation in a university seminar. Recovery was assessed using psychophysiological measures; heart rate and heart rate variability were investigated. Higher levels of students' social self-concept (self-concept depending on social comparison) were linked to poorer recovery from the challenge, whereas higher levels of absolute self-concept (independent of external criteria) were associated with more efficient recovery.

Results: The findings suggest that a focus on one's own abilities (ie, internal performance standard) is linked to more adaptive patterns of responses to challenging situations, while the focus on social comparisons seems to hamper adaptive coping with academic stress.

Conclusion: These findings have consequences not only for learning and instruction but also for students' health and well-being.

Keywords: self-concept, social comparison, achievement situation, heart rate, heart rate variability

Introduction

Presentations and exams are common yet stressful situations for university students.¹ To meet such a challenge adequately, individuals have to activate their mental and physical resources.² However, it is equally important to disengage from the task and recover once the challenge has been met. Thus, successful coping in academic achievement situations requires engagement and activation of resources as well as disengagement and recovery upon completing the stressful situation. These processes of engagement and disengagement are reflected by physiological processes that include dynamic changes in cardiac activity.²⁻⁶

Students differ in how they deal with such challenging situations. While some are able to not only activate resources but also to recover from these situations, others show maladaptive reactions and behaviors. If individuals are not able to cope efficiently with stressful situations, mental and physical health problems may emerge.⁴ This makes it worthwhile to look more closely into individual factors

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influencing how students respond and adapt to academic stressful situations. The present study focuses on a frequently encountered type of achievement situations, presentations in a university seminar. Presentations are a special type of academic achievement situations because they entail several potentially threatening components. Firstly, they entail performance pressure due to grading of a student's academic performance. Furthermore, they entail a social-evaluative threat component because the presentation is carried out in front of a listening and judging audience of an instructor and fellow students. In a study which compared stress responses (indicated by cortisol concentrations) in oral presentations and written examinations, students showed higher stress responses in the presentation situation.⁷

Against this background, the present study investigates to which degree individual self-assessments, ie, academic self-concept,⁸ are related to recovery, as assessed by psychophysiological (cardiac) measures.

Academic Self-Concept And Frames Of Reference

The academic self-concept (in the following only referred to as self-concept) describes the trait-like appraisal of one's own academic abilities and competencies.⁹ It is based on self-evaluative processes and on the use of a certain frame of reference (one might describe a frame of reference as a set of criteria for assessing one's performance). Different dimensions of the self-concept imply the use of different reference frames; specifically, the criterial, the social, the absolute, and the individual self-concept can be distinguished.^{10,11} The criterial self-concept is related to an objective standard (eg, how good are my abilities compared to a performance standard or school standard), the social self-concept is related to social comparison (how good are my abilities compared to others), and the individual self-concept is related to a temporal standard (how well have I developed my abilities). Finally, the absolute self-concept is not related to the use of a certain frame of reference but rather to a general perception of individual abilities.^{10,12} Furthermore, individuals possess self-concepts for different academic domains (languages, science, mathematics, etc.), and their self-assessments may differ across domains. Correlations between the self-concept and academic achievement lie typically around $r = 0.6$ (eg, for mathematics). This shows that self-concept is strongly related to actual achievement and abilities;^{9,12} however, it

does not exactly mirror them.¹³ Altogether, it is an important variable not only for achievement but also regarding learning strategies or emotions in learning.¹⁴ This is illustrated in the following.

The assessment of one's own abilities using different frames of reference serves various functions. It helps to determine one's position in unfamiliar academic situations,¹⁵ and it is connected to a sense of control (or a lack thereof) in an achievement situation.^{16,17} Comparisons against reference frames also have a motivational function. Students who perceive that they exceed their classmates' ability feel more competent and put more effort into their work.¹⁸ Social comparisons may, however, cause pressure and stress and dampen motivation if the comparison reflects one's own deficits, thereby impairing one's self-concept.¹⁹

Up to now, only a few studies have investigated the role of self-concept in coping with academic achievement situations using objective, psychophysiological measures. Our scoping of the literature found only two studies, both in secondary education. In both studies, students' academic self-concept was related to the intensity of stress reactions measured by cortisol levels in stressful academic situations.^{17,20} Students with a higher academic self-concept felt more confident in the situation because they had already done well in similar situations and therefore showed lower stress responses. However, in both studies, self-concept was measured as a composite score that comprised a mixture of items referring to different frames of reference. Thus, conclusions about different aspects of self-concept could not be drawn from these studies. Furthermore, both studies investigated reactivity but not recovery. None of the studies used cardiac measures.

The role of self-concept in recovery from academic stressful evaluative situations has hardly been investigated thus far. In a study on feedback and physiological responses, a mismatch between the self-concept and task feedback (ie, negative feedback in the case of a positive self-concept and vice versa) was related to perseveration on the task as well as prolonged recovery as measured by cardiac variables.^{5,21} However, this study neither distinguished between different frames of reference nor did it investigate the correlation between self-concept and recovery.

Against this background, the present study includes different dimensions of self-concept (criterial, social, absolute, and individual)^{10,11} and investigates their relationship to students' recovery from a real-life academic challenge. For mapping the recovery process objectively and in real time, psychophysiological (cardiac) indicators of recovery were used.

Cardiac Responses To A Stressful Academic Challenge

Cardiac stress responses have essentially two components: (1) the magnitude of activation during the challenge (reactivity) and (2) post-stress recovery, the decline of activation. In terms of heart rate, reactivity implies a response and an increased heart rate during stressful events as a result of the mobilization of energy and task engagement.^{1,22,23} In comparison, recovery can be described as the rate and/or degree to which a post-stress response approaches pre-stress levels.²⁴

Measures of cardiac reactivity and recovery provide information concerning the psychophysiological adjustment to environmental, physiological, and/or mental demands.²⁵ Adaptive coping responses to acute stress are characterized as a distinct initial reaction and efficient recovery after termination of a stressor.²⁶ A delayed recovery of cardiac activation is mainly attributed to a continued mental presence of stressors beyond its actual usefulness^{3,4} and is closely related to perseverative cognition and the propensity for rumination,⁵ which, in turn, are associated with vulnerability to depression and other psychological disturbances.²⁷

Changes in heart rate (HR) and heart rate variability (HRV) are reliable measures of cardiac responses to stress.²⁸ Whereas heart rate displays the time between heartbeats (R-R intervals) and reflects an immediate response to environmental challenges,²⁹ HRV represents the variability of the heart's beat-to-beat intervals.³⁰ Adequate HRV is an indicator for good self-regulatory capacity and adaptability.³¹

The standard deviation of the R-R intervals (SDNN) is an often used HRV index for autonomous nervous system functioning, which reflects all the cyclic components responsible for variability in the period of recording;^{29,31} thus, SDNN is a representative parameter of overall variability of heart rate (calculated from the total of all R-R intervals). Whereas higher SDNN values indicate good adaptability to environmental demands, lower values in SDNN signify a rather poor ability in adjusting the cardiovascular system to environmental demands. SDNN and other HRV-time domain parameters are at least to some extent related to age and gender,³² ie, SDNN is expected to decrease with age and to be a little lower in women. However, the relation between HRV and age in particular is subject to controversy, since most studies rely on samples with small proportions of older participants.^{33–35} Further, it has often been contended as to whether the decrease in HRV is tied to the aging process itself or rather to a deterioration of health, disease, or an increase in use of medication.^{36,37}

Cardiac recovery after giving a real-life presentation has been not extensively investigated to date. Studies which have used such presentation tasks have mostly been carried out in laboratory settings and have used measures of reactivity.^{38,39} Only a few have considered recovery.^{40,41} Yet, recovery after an academic achievement situation is an important indicator of how students cope with the respective situation. Prolonged recovery and the underlying ruminative and self-evaluative processes constitute an (unnecessary) continued involvement with the achievement situation.⁴

Methods

Participants

A total of 69 students took part in the study. One participant was excluded due to an extreme SDNN baseline value. The participants were aged between 20 and 49 years ($M = 24.3$, $SD = 4.8$) (12 men, 56 women) and had studied for at least 4 semesters ($M = 8.4$, $SD = 3.5$). They were all bachelor or master level psychology students, or pre-service teachers studying psychology as their major subject (since the subject of psychology is often taught in Austrian higher secondary schools). All participants were attending a seminar within the psychology study program which required giving a presentation. In all seminars, the seminar language and language of the presentation were German. Overall, German was the native language of 65 participants and three students had excellent knowledge of German as their first foreign language (in which they conducted their studies). The study was performed in accordance with the 1964 Declaration of Helsinki and was approved by the authorized local ethics committee (the ethics committee of the University of Graz). All participants gave their written informed consent to participate and to confirm that their data would be used in an empirical study.

Variables And Measures

Academic Self-Concept

Academic self-concept was assessed using a self-report questionnaire (Skalen zur Erfassung des akademischen Selbstkonzepts [SASK]).¹⁰ This instrument comprises four scales, each measuring a different dimension of academic self-concept: the criterial scale uses a criterion-related frame of reference (eg, "Considering the demands of my studies, it is" ... 1 = difficult to 7 = easy ... "for me to learn something new"; 5 items), the social scale refers

to comparison with others (eg, “I think, I am” ... 1 = less talented to 7 = more talented ... “than my colleagues”; 6 items), the individual scale refers to a comparison of one’s own abilities over time (eg, “Regarding my development, I consider my study-related aptitudes” ... 1 = lower than before to 7 = higher than before; 6 items), and the absolute scale refers to an assessment of abilities without using a specific frame of reference (eg, “I consider my own study-related talent” ... 1 = low to 7 = high; 5 items). All items except one item from the absolute scale required that participants assess themselves in their own field of study.

The SASK was chosen since according to our scoping of the literature, it is the only validated questionnaire in the German language which assesses different facets of self-concept, referring to external and internal frames of reference. The items follow a clear cognitive approach and focus on cognitive assessments of one’s abilities (in contrast to other instruments, which mix affective and cognitive items). The questionnaire has been validated in three studies with university student samples. In all studies, internal consistencies ranged from satisfying to excellent ($\alpha = 0.74$ to $\alpha = 0.89$). Correlations with other questionnaires on self-concept and with questionnaires on self-efficacy, on goal achievement motives, on test anxiety, and on academic performance speak for the convergent and discriminant validity of the SASK.^{10,11}

Recording And Quantification Of Cardiac Variables

The ECG was continuously recorded using Holter ECG devices (sampling rate = 1 kHz; CardioMem® CM 4000, GETEMED Medizin- und Informationstechnik AG) for 42 hrs, beginning in the afternoon before the presentation day and ending on the morning after the presentation. Electrodes (Ambu® Blue Sensor, Ambu GmbH) were placed at thoracic regions. Single artifacts were replaced by interpolation.

Analyses of cardiac variables refer to baseline measures (a 5-min baseline was derived from the 42-hr measures by analyzing ECG data and participants’ documentation, and identifying representative resting periods for each participant; participants were in a sitting position), to the presentation period (first 5 mins of oral presentation), and to the recovery period (first 5 mins after the presentation had officially ended), each in a sitting position. Five-minute means were calculated for investigating HR as well as for HRV (SDNN).

In addition to the mean values, change scores (Δ) were calculated to quantify recovery. Recovery indicates how

much a post-stress response approaches the corresponding pre-stress level. Here, the mean values measured during the baseline were subtracted from the mean values during the recovery period. The resulting two variables are ΔHR and $\Delta SDNN$. Positive values of the HR change scores indicate poorer recovery for HR (because HR increased during the presentation) and negative values of HRV change scores $\Delta SDNN$ indicate poorer recovery of HRV (because HRV decreased during the presentation).

Procedure And Research Design

For the recruitment of participants, lecturers of psychology seminars, in which grading was based on presentations, were contacted. The study was introduced in these seminars and voluntary participants were recruited. Grading was not related to participation in the study. Participants received full information about the study in a first appointment prior to the presentation. There, the students filled in the SASK and gave their written informed consent to participate in the study.

The second appointment was on the day prior to the participants’ presentation. Here, the portable ECG devices were attached, and participants received instructions on how to document their activities during the recording period.

On the following day, participants gave their presentation in a sitting position and afterwards filled in the self-ratings. An investigator involved in the study observed the presentation but did not interrupt or influence the presentation. All instructors of the seminars were informed about the study and gave their consent beforehand.

Participants returned the ECG device and the documentation of their daily activities on the day after the presentation. In total, the ECG-recordings lasted for 42 hrs and covered a period of three calendar days (see also Figure 1).

Results

All statistical analyses were carried out using IBM SPSS Statistics version 25. On average, HR increased ($F_{1.6, 104.6} = 387.5, p < 0.000, \eta_p^2 = 0.85$) from 73.4 bpm (SD = 8.4) at baseline to 118.2 bpm (SD = 19.0) during the presentation, and decreased to 94.7 bpm (SD = 14.5) during the recovery period. Concomitantly, SDNN decreased in response to the challenge ($F_{2, 134} = 28.13, p < 0.000, \eta_p^2 = 0.30$; see Table 1). Changes in cardiac measures are also shown in Figure 2.

Mean scores and further descriptive statistics for self-concept in the present sample are shown in Table 2.

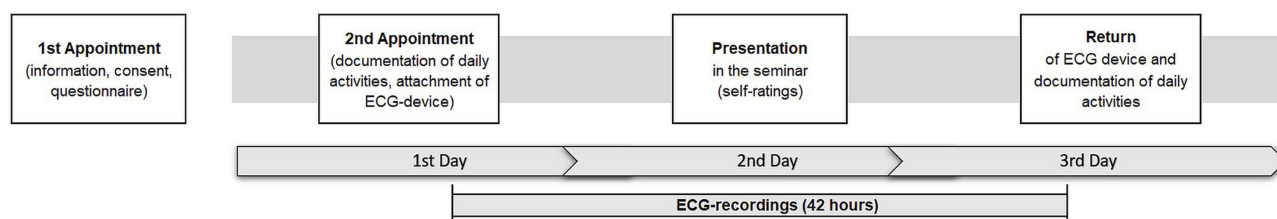


Figure 1 Overview of the procedure.

Standard multiple regression analyses were calculated with Δ HR and Δ SDNN as the dependent variables (see Table 3) and the four self-concept scales as predictors. Moreover, we included age and gender in each regression analysis, since they are often seen as important predictors for changes in HRV parameters.³² The regression method of forced entry was used: With this method, all predictors are added into the model simultaneously.⁴²

Self-concept

The regression analysis for Δ SDNN as criterion ($F_{6, 57} = 6.22$, $p = 0.000$, $R^2 = 0.40$) revealed relationships with the social scale ($\beta = -0.28$, $p = 0.038$) and the absolute scale ($\beta = 0.34$, $p = 0.041$), as well as for gender ($\beta = 0.34$, $p = 0.002$) and age ($\beta = 0.34$, $p = 0.002$). The regression model was not significant for Δ HR ($F_{6, 57} = 1.42$, $p = 0.221$, $R^2 = 0.13$) (see Table 3 for details).

The results indicate that the higher the scores for social self-concept, the less likely it is that the SDNN returns to baseline values (indicating poor recovery). In contrast, the higher one's assessment on the absolute scale, the more likely it is that SDNN approaches baseline levels (indicating more efficient recovery). Further, positive results regarding recovery were also observed for age and gender: older students and females seem to recover more efficiently.

Bivariate correlations between the absolute self-concept, HR, and HRV were around zero (see Table 4). However, the absolute as well as the social self-concepts received significant β -weights in the regression analysis

but with opposite signs. Altogether, the results point at a suppression effect. Even though the absolute self-concept showed a bivariate zero correlation with the criterion variable, once the absolute and the social self-concept were included in the respective regression analysis, higher scores on absolute self-concept predicted faster recovery.

Supplementary Analyses

To substantiate the sensitivity of the analysis, regression analyses were also conducted for cardiac reactivity (defined as difference between challenge and baseline values); in other words, analysis of cardiac changes during the presentation. There were no significant relationships between the predictors age, gender, and the four self-concept scales, and the criterion of cardiac reactivity of HR ($F_{6, 57} = 1.20$, $p = 0.318$, $R^2 = 0.11$). The same result was observed when using as criterion the reactivity of SDNN ($F_{6, 57} = 0.84$, $p = 0.543$, $R^2 = 0.08$).

Discussion

In the present investigation, students' recovery after a challenging presentation in a university seminar was studied using cardiac measures. The expected activating effect of the challenge could be clearly observed. On average, HR was increased by 45 bpm during the presentation, compared to the resting baseline; this effect is in line with previous studies.¹ At 5 mins after the end of the presentation, recovery was still incomplete in most participants, however, with considerable interindividual variability.

Age and gender were significantly related to recovery, as expressed by Δ SDNN. Age was positively related to recovery, ie, older students showed better recovery than younger students (respectively showed a still continuing recovery process). However, age is also related to other variables such as experience with a university study or length of study. These variables might influence the relationship between age and recovery. Concerning gender, female students showed better recovery than male

Table 1 Means And Standard Deviation Of HR And SDNN

Observation period	HR (bpm)		SDNN (ms)	
	M	SD	M	SD
Baseline	73.43	8.44	70.75	25.37
Presentation	118.16	19.01	44.75	25.20
Recovery	94.67	14.53	61.82	26.86
Δ (Recovery - Baseline)	21.23	11.38	-8.93	30.40

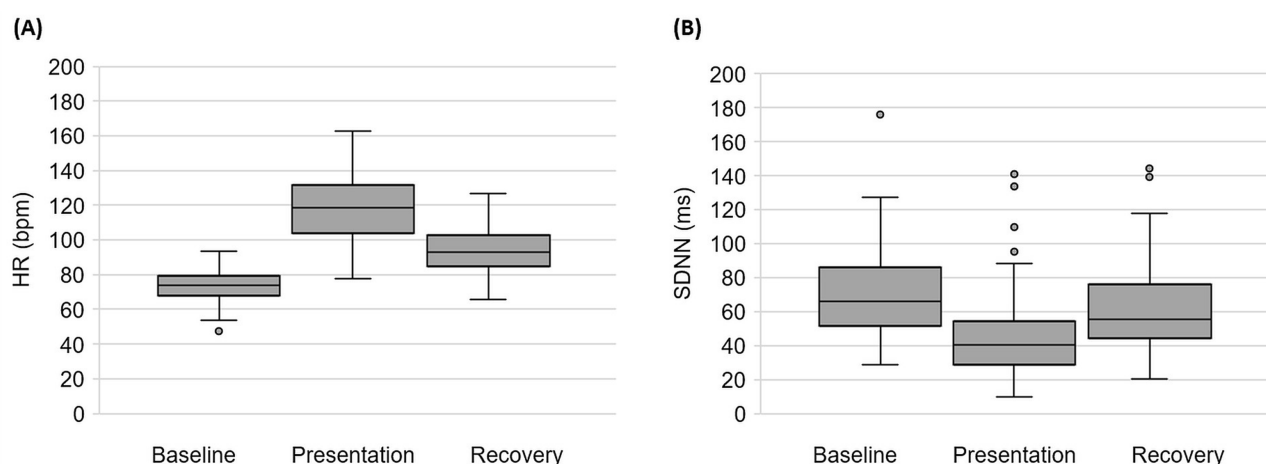


Figure 2 Changes in HR and SDNN over the three observation periods.

Note: Panel (A) displays changes in heart rate (HR) and panel (B) changes in SDNN during the three observation periods.

students. There are several possible reasons for this difference. One study on gender differences concerning oral presentations in secondary education observed various advantages for young women, such as that they prepared more carefully, and were more likely to assume an expert position and to express enthusiasm and engagement.⁴³ Altogether, even though the variables age and gender are related to recovery, they are possibly confounded with other variables such as experience, effort, motivation, etc. In contrast, the self-concept facets clearly reflect

students' self-assessments. Therefore, they are in the focus of the following parts of the discussion.

At first sight, the negative relationship between social self-concept and recovery indices seems to contradict studies which have found a padding effect of a positive self-concept on stress responses.^{17,20} These studies, however, did not look at recovery after termination of a stressor nor did they differentiate between the different dimensions of self-concept.

In the present study, students who considered themselves as being more talented than their colleagues (ie,

Table 2 Descriptive Statistics For The Self-Concept Scales Of SASK

Self-Concept Scales	n	M	SD	α	Min	Max
Criterial	68	5.23	0.69	0.71	3.60	6.80
Social	68	4.61	0.62	0.82	3.50	6.17
Absolute	64	5.24	0.59	0.68	3.80	6.80
Individual	68	5.55	0.69	0.81	3.83	7.00

Table 3 Individual Factors Predicting Cardiac Recovery

Predictor Variables: Self-Concept Scales, Gender, Age	Δ HR			Δ SDNN		
	B	SE B	β	B	SE B	β
Criterial	-0.147	3.12	-0.009	-7.653	7.19	-0.176
Social	2.927	2.94	0.158	-13.968	6.57	-0.282*
Absolute	-7.637	3.77	-0.390*	17.674	8.44	0.336*
Individual	3.604	2.21	0.211	-8.588	4.94	-0.187
Gender	3.835	3.84	-0.092	27.698	8.58	0.340**
Age	0.106	0.39	0.046	2.140	0.66	0.343**

Notes: * $P < 0.05$, ** $P < 0.01$. Δ HR is calculated by subtracting HR during baseline measures from HR during recovery period (see values in Table 1). HR increases due to a stress response; therefore, positive values of Δ HR indicate poorer recovery of HR (less approach towards baseline). Δ SDNN is calculated by subtracting SDNN during baseline measures from SDNN during recovery period. SDNN decreases due to a stress response; therefore, positive values of Δ SDNN indicate more efficient recovery of SDNN (more approach towards baseline).

Table 4 Bivariate Correlations Between SASK Scales Of Academic Self-Concept, Recovery Of HR And SDNN

	2. Social	3. Absolute	4. Individual	5. Δ HR	6. Δ SDNN
1. Criterial	0.598**	0.735**	0.078	-0.172	-0.071
2. Social		0.532**	0.154	-0.015	-0.236
3. Absolute			0.231	-0.246*	0.113
4. Individual				0.145	-0.164
5. Δ HR					-0.354**
6. Δ SDNN					-

Notes: * $P \leq 0.05$, ** $P < 0.01$.

those who had higher social self-concept scores) showed prolonged stress responses. Since delayed recovery is closely related to perseverative cognition, these students seemed to ruminate longer about the achievement situation.^{5,21} Students with high social self-concept scores may be more inclined to compare their performance to that of fellow students and could be motivated to maintain their already high self-concept assessment. Further, perseverative cognition might have been also fostered by the homogeneous nature of students in the seminars (same major and in the same or a similar semester). The processing and evaluation of such subtle differences between fellow students' abilities may entail a higher degree of rumination and thus contribute negatively to recovery, especially for students who seek to maintain their already high social self-concept. The presentations were graded, which might also have encouraged social comparison processes. Thus, it seems plausible that the social self-concept was activated and served as a strong frame of reference for the appraisal of one's abilities.

In contrast to the social self-concept, higher levels of the absolute self-concept were related to more efficient recovery from the challenge. The absolute self-concept scale refers to beliefs about one's subject-specific talent and capabilities without reference to a specific standard; as such, it describes the confidence in one's theoretical capability to successfully achieve in a domain.^{10,12} Therefore, students with a strong absolute self-concept probably do not as much feel the need to engage in perseverative, demanding comparisons with fellow students' performance, since high levels of this type of self-concept provide students with a stable assessment of their abilities. Trust in one's own abilities is related to positive self-attributions and feelings of autonomy.⁴⁴ It seems to be beneficial for one's confidence in his or her own competencies and adaption to rely less on external frames of reference. Reliance on an absolute reference norm, related

only to one's own person, also has the advantage that one's evaluation of performance is not subject to uncontrollable circumstances such as group composition and distribution of abilities in a team.

The developers of the SASK questionnaire describe the absolute self-concept as an overarching concept; its development is formed by experiences in achievement situations and, therefore, there is a natural relationship with the other self-concept dimensions.¹⁰ As such, it is not a completely homogeneous concept. The suppression effect in the present study underlines this assumption. While bivariate correlations of the absolute self-concept and the recovery of HRV were around zero, this scale did contribute positively to recovery and increased the predictive power of the social self-concept by suppressing irrelevant variance of the latter variable.

In the regression analyses, neither the criterial nor the individual self-concept contributed significantly to recovery. This is plausible in the case of the individual self-concept because it does not use an external frame of reference but instead fosters comparisons of present with former individual performance. In contrast, the orientation along a specified criterion plays a more prominent role in academic settings.¹² According to the regression analyses, the criterial self-concept received no significant β -weight. As has been already discussed, the presentation situation might have rather addressed an inter-individual comparison and thus might have favored activation of the social self-concept.

Altogether, the present study suggests that two facets of self-concept are related to students' stress responses in a typical academic situation, such as giving a presentation in a university seminar. The present study is one of the few studies in Educational Psychology which combines physiological (cardiac) data with psychological concepts that are prominent in learning and achievement, ie, learners' academic self-concept. Even though the application of

cardiac measurements for investigating learners' self-concept is still in its early stages, it seems to be a promising approach. The study shows that attitudes and self-assessments are related to physiological responses. Furthermore, the inclusion of cardiac variables allows the investigation of internal processes that are not accessible by self-reports or behavioral observations. Thus, the present study encourages the pursuit of a cross-disciplinary approach and of combining physiological data with validated self-assessments.⁴⁵

Conclusion And Implications

The results have implications for learning and instruction. In a university seminar, teachers or instructors may address different reference norms by means of grading criteria, feedback, evaluation, task allocation to students, etc. The results in this study advise against addressing students' social self-concept and the use of a social frame of reference. Instructors could rather aim at strengthening students' absolute self-concept and enable students to build up and use internal performance standards for self-evaluation, eg, by establishing clear achievement standards and encouraging students to compare their own performance with these standards. Supporting students' recovery by such means may also have an impact on their well-being and coping with stress in the long term.

Importantly, the results of this study concern an especially significant aspect in learning and instruction: feedback given by teachers. The results advise teachers to tie feedback mainly to an overall performance standard and, for example, not to comparisons between classmates. Such feedback would emphasize the standard that should be achieved. Ideally, it would also emphasize the importance of effort.⁴⁶

Limitations And Strengths

Not all variables could be controlled in the real-life setting of the study (for example, variables such as size of audiences, length of presentations, etc). The study was carried out in the domain of psychology and participants were either students majoring in psychology or pre-service teachers with psychology as a main subject. Certainly, the instruction and demands on learning and achievement differ between different academic domains. In some domains achievement situations such as presentations, oral or written examinations are more prominent than in others. Presentations are a frequently encountered achievement situation especially for students of psychology. Therefore, the results are certainly restricted with regard

to generalizability and mainly explain recovery in the domain of psychology and related knowledge domains. The restriction to a specific knowledge domain in this study had the advantage that domain-related frames of reference could be investigated; however, in order to be able to generalize the results, further investigation in other domains is needed.

To our knowledge, the present study is to date the only study which has looked closer into recovery and its relationship with the academic self-concept and its different frames of references. The results emphasize the multidimensionality of the academic self-concept and strongly suggest differentiating between the various dimensions and their impact on, for example, stress responses and recovery.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Kamarck TW, Debski TT, Manuck SB. Enhancing the laboratory-to-life generalizability of cardiovascular reactivity using multiple occasions of measurement. *Psychophysiology*. 2000;37:533–542. doi:10.1111/1469-8986.3740533
2. Gendolla GHE, Richter M. Effort mobilization when the self is involved: some lessons from the cardiovascular system. *Rev Gen Psychol*. 2010;14:212–226. doi:10.1037/a0019742
3. Brosschot JF. Markers of chronic stress: prolonged physiological activation and (un)conscious perseverative cognition. *Neurosci Biobehav Rev*. 2010;35:46–50. doi:10.1016/j.neubiorev.2010.01.004
4. Brosschot JF, Gerin W, Thayer JF. The perseverative cognition hypothesis: a review of worry, prolonged stress-related physiological activation, and health. *J Psychosom Res*. 2006;60:113–124. doi:10.1016/j.jpsychores.2005.06.074
5. Papousek I, Paechter M, Weiss EM, Lackner HK. The tendency to ruminate and the dynamics of heart rate recovery after an ordinary, mildly stressful performance situation. *Pers Individ Dif*. 2017;104:150–154. doi:10.1016/j.paid.2016.08.003
6. Richter M, Gendolla GHE, Wright RA. Three decades of research on motivational intensity theory: what we have learned about effort and what we still don't know. *Adv Motivation Sci*. 2016;3:149–186. doi:10.1016/bs.adms.2016.02.001
7. Preuss D, Schoofs D, Schlotz W, Wolf OT. The stressed student: influence of written examinations and oral presentations on salivary cortisol concentrations in university students. *Stress*. 2010;13(3):221–229. doi:10.3109/10253890903277579
8. Spinath B, Stiensmeier-Pelster J. Goal orientation and achievement: the role of ability self-concept and failure perception. *Learn Instruction*. 2003;13:403–422. doi:10.1016/S0959-4752(02)00014-2
9. Becker M, Neumann M. Context-related changes in academic self-concept development: on the long-term persistence of big-fish-little-pond effects. *Learn Instruction*. 2016;45:31–39. doi:10.1016/j.learninstruc.2016.06.003

10. Dickhäuser O, Schöne C, Spinath B, Stiensmeier-Pelster J. Die Skalen zum akademischen Selbstkonzept. Konstruktion und Überprüfung eines neuen Instrumentes [The academic self concept scales: construction and evaluation of a new instrument]. *Zeitschrift Für Differentielle Und Diagnostische Psychologie*. 2002;23:393–405. doi:10.1024//0170-1789.23.4.393
11. Hoferichter F, Lätsch A, Lazarides R, Raufelder D. The big-fish-little-pond effect on the four facets of academic self-concept. *Front Psychol*. 2018;9:1247. doi:10.3389/fpsyg.2018.01247
12. Schöne C, Dickhäuser O, Spinath B, Stiensmeier-Pelster J. *Skalen Zur Erfassung Des Schulischen Selbstkonzepts (SESSKO) [Scales Assessing Students' Academic Self-Concept]*. [Manual]. Göttingen: Hogrefe; 2012.
13. Ertl B, Luttenberger S, Paechter M. The impact of gender stereotypes on the self-concept of female students in STEM subjects with an under-representation of females. *Front Psychol*. 2017;8:703. doi:10.3389/fpsyg.2017.00703
14. Macher D, Paechter M, Papousek I, Ruggeri K, Freudenthaler H, Arendasy M. Statistics anxiety, state anxiety during an examination, and academic achievement. *Br J Educ Psychol*. 2013;83:535–549. doi:10.1111/j.2044-8279.2012.02081.x
15. Gore JS, Cross SE. Who am I becoming? A theoretical framework for understanding self-concept change. *Self Identity*. 2014;13:740–764. doi:10.1080/15298868.2014.933712
16. Bieg M, Goetz T, Lipnevich AA. What students think they feel differs from what they really feel – academic self-concept moderates the discrepancy between students' trait and state emotional self-reports. *PLoS One*. 2014;9(3):e92563. doi:10.1371/journal.pone.0092563
17. Kärner T, Sembill D, Aßmann C, Friederichs E, Carstensen CH. Analysis of person-situation interactions in educational settings via cross-classified multilevel longitudinal modelling: illustrated with the example of students' stress experience. *Frontline Learn Res*. 2017;5(1):16–42. doi:10.14786/flr.v5i1.137
18. Dweck CS. Motivational processes affecting learning. *Am Psychologist*. 1986;41:1040–1048. doi:10.1037/0003-066X.41.10.1040
19. Buunk AP, Cohen-Schotanus J, van Nek RJ. Why and how people engage in social comparison while learning social skills in groups. *Group Dyn*. 2007;11:140–152. doi:10.1037/1089-2699.11.3.140
20. Minkley N, Westerholt DM, Kirchner WH. Academic self-concept of ability and cortisol reactivity. *Anxiety Stress Coping*. 2013;27(3):303–316. doi:10.1080/10615806.2013.848273
21. Papousek I, Paechter M, Lackner HK. Delayed psychophysiological recovery after self-concept-inconsistent negative performance feedback. *Int J Psychophysiol*. 2011;82:275–282. doi:10.1016/j.ijpsycho.2011.09.013
22. Richter M, Friedrich A, Gendolla GHE. Task difficulty effects on cardiac activity. *Psychophysiology*. 2008;45:869–875. doi:10.1111/j.1469-8986.2008.00688.x
23. Merz CJ, Wolf OT. Examination of cortisol and state anxiety at an academic setting with and without oral presentation. *Stress*. 2015;18:138–142. doi:10.3109/10253890.2014.989206
24. Haynes SN, Gannon LR, Orimoto L, O'Brien WH, Brandt M. Psychophysiological assessment of poststress recovery. *Psychol Assess*. 1991;3:356–365. doi:10.1037/1040-3590.3.3.356
25. Radstaal M, Geurts SA, Brosschot JF, Cillessen AH, Kompier MA. The role of affect and rumination in cardiovascular recovery from stress. *Int J Psychophysiol*. 2011;81:237–244. doi:10.1016/j.ijpsycho.2011.06.017
26. Friedman BH, Thayer JF. Anxiety and autonomic flexibility: a cardiovascular approach. *Biol Psychol*. 1998;47:243–263. doi:10.1016/S0301-0511(97)00027-6
27. Abela JRZ, Hankin BL. Rumination as a vulnerability factor to depression during the transition from early to middle adolescence: a multiwave longitudinal study. *J Abnorm Psychol*. 2011;120(2):259–271. doi:10.1037/a0022796
28. Kreibitz S. Autonomic nervous system activity in emotion: a review. *Biol Psychol*. 2010;84:394–421. doi:10.1016/j.biopsycho.2010.03.010
29. Javorka M, Žila I, Balhárek T, Javorka K. Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Braz J Med Biol Res*. 2002;35:991–1000. doi:10.1590/S0100-879X2002000800018
30. Dong J-G. The role of heart rate variability in sports physiology (Review). *Exp Ther Medication*. 2016;11:1531–1536. doi:10.3892/etm.2016.3104
31. Shaffer F, McCraty R, Zerr CL. A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. *Front Psychol*. 2014;5:1040. doi:10.3389/fpsyg.2014.01040
32. Bonnemeier H, Richardt G, Potratz J, et al. Circadian profile of cardiac autonomic nervous modulation in healthy sub-jects: differing effects of aging and gender on heart rate variability. *J Cardiovasc Electrophysiol*. 2003;14:791–799. doi:10.1046/j.1540-8167.2003.03078.x
33. Accardo A, De Dea F, Cinquetti M, Merlo M, Sinagra G. Influence of aging on short- and long-term heart rate variability in patients with heart failure. In: Kyriacou E, Christofides S, Pattichis C, editors. *XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016*. IFMBE Proceedings, vol. 57. 2016. Cham: Springer.
34. Ryan SM, Goldberger AL, Pincus SM, Mietus J, Lipsitz LA. Gender- and age-related differences in heart rate dynamics: are women more complex than men? *J Am Coll Cardiol*. 1994;24:1700–1707. doi:10.1016/0735-1097(94)90177-5
35. Zulfiqar U, Jurivich DA, Gao W, Singer DH. Relation of high heart rate variability to healthy longevity. *Am J Cardiol*. 2010;105(8):1181–1185. Epub 2010 Feb 20. doi:10.1016/j.amjcard.2009.12.022
36. de Geus EJC, Gianaros PJ, Brindle RC, Jennings JR, Berntson GG. Should heart rate variability be “corrected” for heart rate? Biological, quantitative, and interpretive considerations. *Psychophysiology*. 2018;56:e1387. doi:10.1111/psyp.13287
37. Jandackova VK, Scholes S, Britton A, Steptoe A. Are changes in heart rate variability in middle-aged and older people normative or caused by pathological conditions? Findings from a large population-based longitudinal cohort study. *J Am Heart Assoc*. 2016;1:e002365. doi:10.1161/JAHA.111.002361
38. Al'Absi M, Bongard S, Buchanan T, Pincomb GA, Licinio J, Lovallo WR. Cardiovascular and neuroendocrine adjustment to public speaking and mental arithmetic stressors. *Psychophysiology*. 1997;34:266–275. doi:10.1111/j.1469-8986.1997.tb02397.x
39. Kirschbaum C, Pirke K-M, Hellhammer DH. The trier social stress test – A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*. 1993;28(76–81). doi:10.1159/000119004
40. Souza GGL, Mendonça-de-Souza ACF, Barros EM, et al. Resilience and vagal tone predict cardiac recovery from acute social stress. *Stress*. 2007;10(4):368–374. doi:10.1080/10253890701419886
41. Spangler G. Psychological and physiological responses during an exam and their relation to personality characteristics. *Psychoneuroendocrinology*. 1997;22(6):423–441. doi:10.1016/S0306-4530(97)00040-1
42. Field A. *Discovering Statistics Using IBM SPSS Statistics*. 4th ed. London: Sage; 2013.
43. Svenkerud S, Dalland CP, Klette K. Social positioning in boys' and girls' oral presentations. *Educ Inq*. 2013;4(4):715–733. doi:10.3402/edui.v4i4.23218
44. Weinfield N, Sroufe LA, Egeland B, Carlson E. Individual differences in infant-caregiver-attachment. In: Cassidy J, Shaver P, editors. *Handbook of Attachment*. 2nd ed. New York: Guilford; 2008:pp. 78–101.
45. Wimmer S, Lackner HK, Papousek I, Paechter M. Goal orientations and activation of approach versus avoidance motivation while awaiting an achievement situation in the laboratory. *Front Psychol*. 2018;9:1552. doi:10.3389/fpsyg.2018.01552
46. Skipper Y, Douglas K. Is no praise good praise? Effects of positive feedback on children's and university students' responses to subsequent failures. *Br J Educ Psychol*. 2012;82:327–339. doi:10.1111/j.2044-8279.2011.02028.x

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