Psychoneuroendocrinology 105 (2019) 172–177

Contents lists available at ScienceDirect

Psychoneuroendocrinology

journal homepage: www.elsevier.com/locate/psyneuen

Endocrine and psychological stress response in simulated doctor-patient interactions in medical education

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ARTICLE INFO

Keywords:
Cortisol
Acute psychological stress
Communication skills
Medical education
Simulated patients
Standardized patients

ABSTRACT

Background: Training of doctor-patient interactions by means of patient actors is considered a useful didactic tool in medical education. However, though students report it as being highly stressful little systematic research has verified this notion.
Aims: To assess the endocrine and psychological stress responses of students in the doctor vs. the observer role in simulated doctor-patient interactions.
Methods: Salivary cortisol and anxiety was assessed in N = 86 participants of a mandatory course on doctor-patient interactions on three consecutive days. During two of these days they were in the observer role and gave feedback to another student and on one of these days they were in the doctor role and were being given feedback. Saliva was sampled at 4 points in time per day: prior to interaction (T1); after watching the video of the interaction (T2); after feedback (T3); after observation of another interaction (T4). Assessments on observer days took place at the respective time points and at the same time of the day. 3-way mixed ANOVAs were computed with the factors "day of data sampling" (F1); "day with doctor role" (F2); "measurement time"(F3).
Results: Significant two-way interactions F1 × F2 and three-way interactions F1 × F2 × F3 were observed both for cortisol and for anxiety (all $p < .001$). Neither cortisol nor anxiety were related to task severity. Anxiety at T1 correlated with cortisol increase from T1 to T2 ($r = .266$; $p = .013$).
Discussion: Results confirm that playing the doctor role in a simulated doctor-patient interaction represents a significant stressor in medical students. Effect sizes considerably exceed those observed in laboratory stress. This brings about new questions regarding moderating factors, effects of repetitions and relationship to medical performance. The ecological validity of this stressor can also make it a useful tool in basic endocrine research.

1. Introduction

Simulated patient-doctor interviews are an important didactic tool in the education of medical students (Cleland et al., 2009). They allow training of elementary skills for establishing a good patient-physician relationship and for dealing with demanding doctor-patient interactions like breaking bad news. Thereby, medical curricula throughout the world include such simulation trainings (Association of American Medical Colleges (AAMC), 1998; Fröhmel et al., 2007; Härtl et al., 2011; Kruppa et al., 2009) and they are often considered to be indispensable for adequate medical training. An important feature of simulated patient contacts is that students can make experiences and train their skills without being in danger of harming a real patient. Furthermore, they allow for a differentiated feedback which often is given in a 360° perspective to the student, i.e. the (self)feedback is given by the student him- or herself, by the other students in the same course, by the patient actor or actress and by the instructor (see Edwards and Ewen, 2000; Lepsinger and Lucia, 1997). While students appear to appreciate these advantages of simulated patient contacts they often report that they experience being the "physician" in these interaction as an important high level stressor. Still, there is only little scientific evidence for such a notion. The few existing studies suffer from methodological problems, most importantly they often do not include a control group (Cohen et al., 2003; Hulsman et al., 2010; Pottier et al., 2013; Rieber et al., 2009; Struder et al., 2017; Van Dulmen et al., 2007). Similarly, little is known about endocrine alterations in response to simulated patient interviews. In fact, only two studies analyzing cortisol responses to simulated patient interviews in medical students could be found (Pottier et al., 2013; Van Dulmen et al., 2007). While Van Dulmen et al. (2007) observed higher cortisol levels on the day of the interview as compared to another day they found no difference between cortisol concentrations assessed 5 min prior as compared to 10 min after

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https://doi.org/10.1016/j.psyneuen.2018.09.028
Received 20 June 2018; Received in revised form 17 September 2018; Accepted 18 September 2018

the interview. A control group, however, was missing in this study. In contrast, Pottier et al. (2013) observed higher pre-post-increases of cortisol when comparing a high stress condition (e.g. non-cooperative patient) with a low stress condition (without specific stressful components) in a randomized trial. Still, this study is lacking an adequate control condition allowing to quantify the absolute cortisol response to the stressor of being the physician in a simulated patient interview. Thus, even though the didactic benefits of simulated patient interviews have been studied and discussed in detail (Barth and Lannen, 2007; Lane and Rollnick, 2007) their potential effect as a stressor has rarely been addressed and with ambiguous results.

Still, understanding whether and to what degree such a situation reflects a stressor is important for several reasons. First of all, it is important for instructors, the patient actors, and the students themselves to understand the psychological situation of the student in the interview. Such an understanding might ease adequate preparation of the interview and adequate responses to it. Furthermore, if the interview was a potent stressor it would be useful to further study the relationship between its stressor qualities, the performance of the student, students' traits, situational factors, etc. As simulated interviews are often parts of longitudinal curricula, one might also analyze whether, when and to what degree stress responses change over time and whether these changes are related to the factors already named. Finally, basic psychoendocrinological research might benefit from such insights as the interview situations might represent a fairly standardized stressor of high ecological validity.

The present study thereby aimed to assess the psychological and endocrine response of medical students to a simulated patient interview in a well-controlled design with adequate control conditions and to analyze the course of these alterations in more detail. We hypothesized that students within the interview situation would report higher psychological distress and show higher salivary cortisol levels compared to a) the same students on other days during the course when they were not involved in an interview and b) other students on the same day within the same course but without an interview during the respective day. We also hypothesized that stress responses would depend on the severity of the task with stronger responses to the more challenging tasks (e.g. breaking bad news).

2. Material and methods

2.1. Ethics

The design of the present study was approved by the local ethics committee (study no. 21/12) and was found to conform to the WHO principles of research with humans. All participants gave their informed written consent.

2.2. Participants and recruitment

Participants were regular attendees of an obligatory one-week course (Monday–Friday, 9–16 h) on doctor-patient interaction provided in the preclinical studies of medicine in the second year of studies. No further inclusion or exclusion criteria were applied. Recruitment took place prior to inscription into the course and students were informed that their participation would be of no influence on any academic condition or evaluation and that most data assessment would take place during the regular course. A compensation of 15 € was offered. A course group comprised 15 students and care was taken to not to mix up participants and non-participants in order not to disturb non-participants by additional activities related to the study. Considering sample size computation (see below), recruitment was stopped after 90 students had volunteered for the study. Six course groups with participants were formed. The curricula of the course groups with and without study participants were exactly the same.

2.3. Description of the educational setting and of the stressor

The first two days of the course consist of repetition and extension of theoretical input already provided in lectures and seminars and exercises helping the students to gain insight into basic principles of interaction. Amongst them are exercises on the meaning of physical closeness and distance, encoding and decoding of information, the meaning of gesture and mimics, etc. An important part of the didactic program is a 360° feedback given to the students, i.e. self-feedback, feedback by the patient actor, feedback by the fellow students and feedback by the instructor. Thus, students are also taught feedback rules for the upcoming simulation situations. Most importantly they are taught how to deal with each other with appreciation and how to provide their feedback in an appreciative though honest manner. Furthermore, they are instructed to encircle negative feedback by naming aspects they appreciate. Feedback should also be given in a concrete and constructive manner and feedback criteria are worked out jointly in order to help students become most specific with their comments. When being in the situation of an addressee of feedback they are encouraged to consider the benefits of constructive feedback and are asked to abandon defensive reactions. Prior to the course persons who would mimic the patients had been recruited, trained in their roles and in the same feedback rules. Role scripts are provided but patients are encouraged to extemporize when adequate. Simulated patient-doctor interactions are scheduled for Wednesday, Thursday and Friday. On Wednesday, the main task is to accomplish an ordinary anamnestic interview; on Thursday, the task is extended as they should now consider emotional reactions of the patient and respond to them adequately. The main task on Friday consists of breaking bad news. The respective days begin with an introduction into the main task to be accomplished.

At commencement of the course students are informed that all of them would be involved in one simulated doctor-patient interaction where they would play the role of the doctor. They are informed about the upcoming tasks and are asked to name their preference for one or the other task. Lots are drawn in case that preferences are unevenly distributed. As the course takes place prior to clinical education, students are provided with the necessary medical information about symptoms, possible causes, prognosis, therapeutic options etc. at that time.

Simulated doctor patient interactions last an average of 10 min. They take place in front of the course at a separate table and are videotaped. The observing students take notes during the interaction for later feedback. After the interaction the patient, the other students and the instructor prepare their feedback while the doctor-student watches his or her video in order to provide a self-feedback in front of the group. Afterwards he or she is provided with the feedback by the other students, by the instructor and by the patient actor or actress in the above mentioned appreciative manner. A main task of the instructor in this situation is to make sure that feedback is given according to the above mentioned rules.

2.4. Design and quasi-experimental variable

Prior to the course, students were informed about the sampling procedures and that it would be essential not to eat, drink anything else than water or smoke within 1 h prior to data sampling and to be awake at least one hour before the beginning of the course. All students provided salivary samples and questionnaire data on all three days of simulated doctor-patient interactions. During one of these days, they were in the doctor-student situation and on the other two days they were in the observer-student situation. Care was taken that for each student data assessment took place at the same time of the day. The data assessed in the observer-student situation thus reflect a within-control for the same student and a between-control for the doctor-patient interactions of the other students (see also Table 1).

Table 1
Study design.

Between factor (groups) Day with doctor role	Within factor (repeated measurement) Day of sampling		
	Wednesday	Thursday	Friday
Wednesday	Doctor role (N=18)	Observer role (N=18)	Observer role (N=18)
Thursday	Observer role (N=34)	Doctor role (N=34)	Observer role (N=34)
Friday	Observer role (N=34)	Observer role (N=34)	Doctor role (N=34)

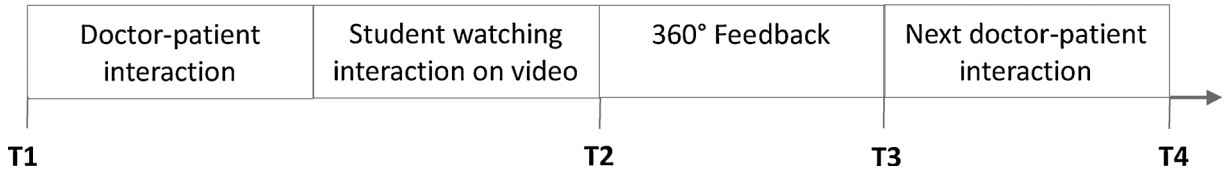

Fig. 1. Different episodes within data assessment. At each time point (T1–T4) a saliva sample was taken and state anxiety assessed. T1: immediately prior to the interaction; T2: after the students had watched the video of their interaction; T3: after feedback had been given; T4: after the following doctor-patient interaction of another student. Mean time between time points of data assessment: T1–T2: 26.5 min; T2–T3: 15.7 min; T3–T4: 15.8 min.

Salivary samples and state anxiety were assessed at four time points: T1: Immediately prior to the interaction; T2: after the students had watched their videos (i.e, appr. 25 min after the first sample); T3: immediately after 360° feedback had been given (appr. 15 min after the second sample); T4: immediately after the following simulated doctor-patient interaction (appr. 15 min after the third sample). Thus, in total 12 samples were taken per student. For the different episodes and time points of data assessment see also Fig. 1.

2.5. Dependent variables

Salivary cortisol was assessed as described previously (Deinzer et al., 2004; Zöller et al., 2010). Briefly, students were asked to provide 3 min saliva samples by means of Salivettes (Sarstedt, Nümbrecht, Germany) which were afterwards stored at −18 °C until analysis by the use of commercial enzyme immunoassays (ELISA; IBL International, Hamburg, Germany). All analyses were run in duplicate and the respective means were included into statistical analyses. Intra- and inter-assay coefficients of variation were 3.1–7.3% and 6.4–8.8%, respectively.

State anxiety was assessed by the state part of the German version of the State-Trait-Inventory which has been validated in several studies (Laux et al., 1981). Notwithstanding, items were provided as visual analogue scales (instead of a 4-point rating) and students were asked to refer with their ratings to the preceding 10 min (instead of merely considering how they feel in that moment).

2.6. Control variables

As no inclusion or exclusion criteria were applied, a number of control variables were assessed to be included as covariates into the analyses. These were gender, chronic stress (Trier inventory of chronic stress; Schulz et al., 2004), trait anxiety and depression (trait part of the State-Trait Anxiety and Depression Inventory, Laux et al., 2013) as well as empathy and taking perspectives of others (Questionnaire empathy and perspective taking; Maes et al., 1995). With respect to women, use of oral contraceptive was assessed. Additionally, it had also been planned to assess the phase within the menstrual cycle as another covariate. However, when asked about the mean duration of their menstrual cycle, a considerable part of the female students reported the length of their menstruation instead the lengths of their menstrual cycle. Thus, it was impossible to estimate in which phase of the cycle they were during the study.

2.7. Statistical analysis

Sample size was computed by GPower (Faul et al., 2007) in order to detect at least large effect sizes with $\alpha = 5\%$ and a power of $1\text{-}ß = 0.95$ in all analyses. Statistical analyses were run by SPSS 24. To analyze effects of the interview situations 3-way mixed ANOVAs were computed with the factors “day of data sampling” (within: Wednesday, Thursday, Friday); “day with doctor role” (between: Wednesday, Thursday, Friday); “measurement time” (within: T1–T4). Analyses were run both, with inclusion of all control variables as covariates and without covariates. Greenhouse-Geisser-corrections were made to correct for deviations from the sphericity assumption. Results are depicted with original degrees of freedom and Greenhouse-Geisser’s epsilon. Partial η^2 is reported as an estimate of effect size within ANOVA. For further description, effect sizes of the differences according to role (doctor role vs. observer role) were computed. For these analyses, data assessed at the same measurement time of the two observer role days were aggregated and compared to the respective values of the day when the students were in the doctor role. Cohen’s d was computed with the standard deviation of the observer role days as reference.

3. Results

Of the 90 students involved, 4 did not or not fully participate in the course. Thus, data sets of N = 86 students (46 women, 40 men) were available for analyses. 26 women were users of oral contraceptives. Mean age of participants was 21.5 years (± 2.40). The doctor-patient interactions lasted an average of 10.04 (± 2.30) minutes.

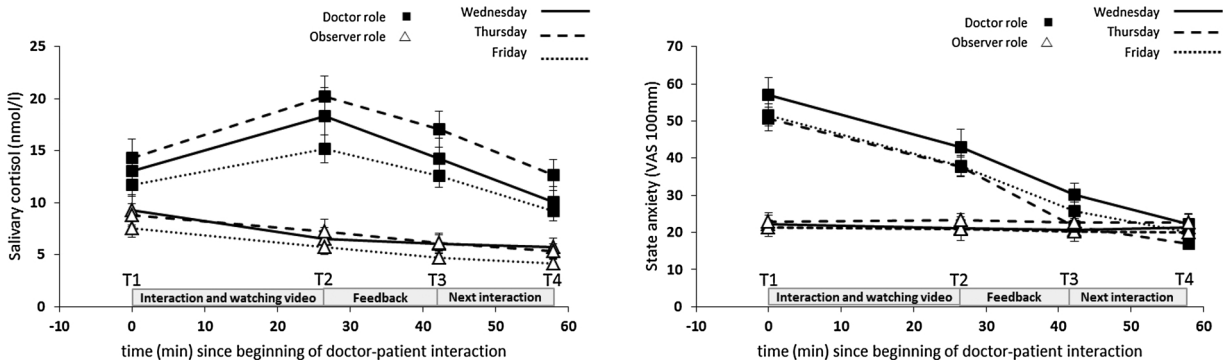

Fig. 2. Mean and SEM of salivary cortisol and state anxiety at the respective time points of data assessment in the three different groups who had their doctor-patient-interactions at different days. T1: immediately prior to the interaction; T2: after the students had watched the video of their interaction; T3: after feedback had been given; T4: after the following doctor-patient interaction of another student.

Results of the three groups at the three measurement days are shown in Fig. 2.

Regarding salivary cortisol levels, ANCOVA revealed a significant two way interaction of "day of data assessment" and "day with doctor role" ($F_{4/154} = 49.527$; $p < .001$; $\eta^2 = .56$; $\varepsilon = .957$) as well as a significant three-way interaction between "day of data assessment", "day with doctor role" and "measurement time" ($F_{12/462} = 16.541$; $p < .001$; $\eta^2 = .30$; $\varepsilon = .668$). There were no main effects of "measurement time", "day of assessment" or "day with doctor role" (all $F < 1.09$; all $p > .34$) nor any further significant interactions between these factors (all $F < 1.47$; all $p > .20$).

With respect to state anxiety, ANCOVA revealed similar results with a significant two-way interaction of "day of data assessment" and "day with doctor role" ($F_{4/154} = 46.936$; $p < .001$; $\eta^2 = .55$; $\varepsilon = .971$) and a significant three-way interaction between "day of data assessment", "day with doctor role" and "measurement time" ($F_{12/462} = 54.674$; $p < .001$; $\eta^2 = .59$; $\varepsilon = .816$). There were no main effects of "measurement time", "day of assessment" or "day with doctor role" (all $F < .61$; all $p > .54$) nor any further significant interactions between these factors (all $F < 1.15$; all $p > .33$).

Results of cortisol and anxiety analyses remain the same when ANOVAs are run without including covariates. Within women, the effects were seen regardless of whether the use of oral contraceptives was included as covariate or not (data not shown).

No continuous relationship between task severity and, both cortisol and anxiety can be seen.

Analyses of effect sizes of cortisol and anxiety responses to the doctor role indicate very large effect sizes (see Fig. 3). Cortisol excretion at doctor role days exceeded those at control days by 2 standard deviations, anxiety responses showed effect sizes $d > 3$.

A significant correlation ($r = .266$; $p = 0.013$) was observed between anxiety prior to the interaction (T1) and the cortisol increase from T1 to after the interaction (T2).

4. Discussion

Simulated doctor-patient interactions with patient actors and a structured feedback to students in the doctor role form a useful didactic tool in medical education (Frank, 2005) and are appreciated as such by most of the students. Still, they often report that being in the doctor role is a significant stressor. Yet, little data has been available so far to validate this notion. Thus, the present study aimed to assess students' cortisol and anxiety responses to playing the doctor role in a simulated doctor patient interaction. It was hypothesized that students would show higher cortisol and anxiety levels when being in the doctor role as compared to the observer role and that the magnitude of the response would increase with the task severity of the doctor-patient interaction. Attendees of a mandatory course on the constitution of doctor patient relationships were assessed on three consecutive days. During one of these days they were in the doctor role while on the other two days they were in the observer role.

As hypothesized, there was a significant effect of being in the doctor role as compared to the observer role. Students showed strong psychological and endocrine stress responses. In fact, effect sizes of cortisol increases exceeded those of standard laboratory stressors with social evaluative components considerably. Such stressors are considered the most effective ones in psychological laboratory research but their effects hardly exceed $d = 1$ (Dickerson and Kemeny, 2004). In the present study effect sizes of $d > 2.0$ were found (see Fig. 3). Thus, the notion that being in the doctor role is a profound stressor is strongly supported by the present study.

The study also supports the interpretation of results by van Dulmen

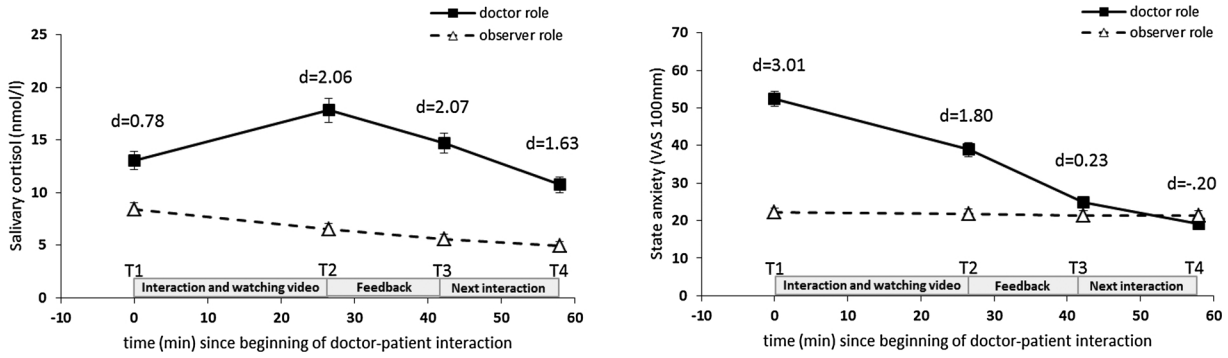

Fig. 3. Effect sizes d of being in the doctor role as compared to the observer role at the different measurement time points for salivary cortisol and state anxiety. For illustration, means and SEMs at the respective time points of data assessment are shown. T1: immediately prior to the interaction; T2: after the students had watched the video of their interaction; T3: after feedback had been given; T4: after the following doctor-patient interaction of another student.

et al. (2007) who had found higher cortisol levels on doctor role vs. control days even prior to the interaction, indicating a strong anticipatory response. However, in their study, they were missing a control assessment at the same day in non-stressed students. The present study allows for such a comparison and confirms the result of an anticipatory increase of cortisol responses which are visible both, in within- and in between-comparisons (see Figs. 2 and 3). In the present study, however, a further increase is seen in cortisol after the interaction which is not observed by van Dulmen et al. (2007). This could be due to differences in the tasks (van Dulmen et al. (2007) just focused on delivering medical information while in the present study the focus was on the doctor-patient interaction), differences in the setting (van Dulmen et al. (2007) do not report about structured feedback as provided in the present study), or perhaps in differences of the time line (interactions in the present study lasted an average of about 10 min while in van Dulmen et al. (2007) such an information is missing). The course of cortisol secretion in the present study resembles the course seen in experimental studies with social evaluative stressors. In these studies, the maximum cortisol is found typically 20–40 min after stress onset and reducing cortisol levels thereafter (Dickerson and Kemeny, 2004).

No support is given by the present study that the magnitude of the stress response increases with the severity of the task. Even though cortisol levels are highest on the third (and most difficult day) those students who have their interactions on the first day (with the least complex task) exceed those who are in the doctor role during the second day. Thus, there is no continuous relationship between task severity and cortisol response. Regarding anxiety, highest levels are observed in students on the first day (see Fig. 1) and anxiety is positively related to cortisol increase. This indicates that the novelty of the situation and anticipatory anxiety might be of importance, too. And indeed, in the present study the students make their very first experience with a didactic situation involving a patient actor and a structured 360° feedback. This marks a considerable difference between the current study and that of Pottier et al. (2013). In a randomized controlled trial, these authors had observed a higher increase of cortisol in a more complex interaction as compared to a less complex interaction. However, they purposefully reduced novelty by involving students a week before the experiment in a first simulated doctor patient interaction (which also served as baseline). In the present study, novelty and task severity are confounded and that might be one reason why we could not find a clear relationship between task severity and cortisol responses.

This poses the question whether cortisol responses to doctor patient simulations change with increasing experience. In earlier studies, habituation to repetitive application of a standard laboratory stressor has been observed (Schommer et al., 2003; Wüst et al., 2005). The present stress situation, however, allows the students to realize some of their strengths and weaknesses potentially affecting their future professional success. Thus, it might be of higher relevance to them. This could also lead to sensitization. This would be an important question for further research which should also analyze whether the responses to the first experience and the way students cope with this experience would be predictive of the responses seen in later interactions. For instance, post-stress rumination has been shown to be associated with a lesser degree of habituation (Gianferante et al., 2014). This is one of several questions arising from this study which should be addressed by future research. Another question is the relationship between the stress response and the performance of the students. In an earlier study on simulated emergency situations no correlation was found between the cortisol response within the situation and the performance. However, a significant positive relationship of considerable magnitude (r = .486) was found between the cortisol response to standard laboratory stress and the medical performance in the emergency simulation (Keitel et al., 2011). Still, another research question would be to identify factors within the setting which moderate the stress response and the performance. In the present study, for instance, doctor students, observer students, and instructors were situated in the same room during the simulated doctor-patient interaction. How would responses change when the interaction was in a separate room with no other persons present and observations would be realized via video transmission or a one-way mirror?

The present study brings about new insights concerning the stressor characteristics of a standard didactic situation in medical education. Furthermore, it poses a number of new research questions which are of interest both for basic research on endocrine stress responses and for research in medical education. It is well controlled, as the sequence of the doctor and the observer situation is counterbalanced and the time of the day is controlled. Furthermore, the design allows for additional between comparisons of the study days. Its ecological validity is high as it analyzes the stress response to a real life situation. Beside these strengths it also has some limitations. First of all, in the present study the novelty and the severity of the task are confounded. This might have masked effects of the severity which had been observed elsewhere (Cohen et al., 2003; Pottier et al., 2013). Second, though intended, it was not possible to control for the menstrual phase of the female students due to problems with data assessment. Still, this factor should be of low impact on the overall results as all assessments were done within three days and such intraindividual comparisons should not be affected by considerable hormonal changes due to menstrual cycle. Finally, the design of the present study does not permit relating the medical performance of the students to their stress response as the three situations focused on different aspects of performance and thus no homogenous performance measure could be derived.

To summarize, being in the doctor role during a simulated doctor-patient interaction appears to be a highly stressful situation for medical students eliciting strong endocrine responses. This has to be taken into account when teaching communication skills with simulated patients in medical education. Future research should further analyze its change over time, moderating factors and relationships between the stress response and the medical performance in that situation. Regarding basic research, this stressor combines characteristics, known to be important for activating the HPA axis, i.e. novelty and evaluative threat (Dickerson and Kemeny, 2004). Its ecological validity is very high. At the same time, it refrains from signals inducing feeling of being excluded which often form an explicit or implicit part of standard laboratory stressors (Deinzer et al., 2004; Frisch et al., 2015). This is important as exclusion has been found to moderate the stress response (Weik et al., 2010, 2013, 2017).

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