The human side of animal experimentation: A qualitative, exploratory study into work-related stress and coping in animal experimenters

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Abstract: Besides the pervasive controversy of animal experimentation in society, ethics and science, the human experimenter side of laboratory animal studies is a relatively underrepresented topic in human-animal interaction research. Few studies have addressed scientists' stress responses to animal experiments. The main aim of this study was to assess work-related stress by means of salivary cortisol secretion, coping strategies, self-esteem, pet attitude and personality traits in academic researchers who regularly perform invasive animal experiments. Invitation to participate in the study resulted in a response rate of 15.4% of 65 invited scientists, of which only four (6.15%) completed data collection. Study participants carried out saliva sampling on working days with and without animal experiments, completed a semi-structured qualitative interview and psychological questionnaires. Salivary cortisol (SC) was measured via enzyme immunoassay. The results indicate that animal experimenters used problem-focused and emotion-focused coping strategies. Three participants reached above average values in self-esteem. Pet attitudes scores were moderately positive. Three out of four animal experimenters reached high scores on the personality dimensions 'openness to experience', 'agreeableness' and 'conscientiousness'. In the absence of an acute increase in SC related to animal experimentation, two out of four participants exhibited an altered circadian pattern of SC secretion only on working days with animal experiments. Although and as a matter of fact because only four of 65 invited scientists volunteered to participate, we discussed the seemingly low willingness of researchers to participate in such a study based on a theoretical analysis, particularly highlighting the concept of deindividuation and provide suggestions for future research.

Keywords: working stress; salivary cortisol; coping; animal experimentation; deindividuation

HIGHLIGHTS

- Only few scientists who regularly performanimal experiments were willing to participate in a study on work-related stress
- Qualitative data analysis revealed elevated salivary cortisol levels in the evening in two out of four animal experimenters
- Animal experimenters used problem-focused and emotion-focused stress coping strategies

• Self-esteem scores in three out of four animal experimenters were above the Austrian average
• Pet attitudes scores were moderately positive in all study participants
• Three out of four animal experimenters reached high scores on the personality dimensions 'openness to experience', 'agreeableness' and 'conscientiousness'

INTRODUCTION

Animal experimentation is besides livestock farming probably the most discussed issue in animal ethics (Binder et al., 2013). Animal experimenters are faced with the public opinion on animal experiments (Ehinger, 1986), they have to morally justify their work (Perry, 2007; Binder et al., 2013), they have to deal with related experimental procedures and finally decide about an animal's death (Ehinger, 1986). According to Ormandy & Schuppli (2014), influencing factors for the public view on animal experimentation are (1) personal and cultural characteristics such as age, gender, experience with animals and religion (notably to mention that Phillips et al. (2012) found the nationality had no significant influence on the opinion on animal experimentation1); (2) animal characteristics such as species and sentience; and (3) research characteristics such as type, availability of alternatives and level of harm. Moreover, scientists play a key role in the whole research process (Binder & Grimm, 2013) and bear particular responsibility for the quality of work, which, in turn, is related to personal variables and attitudes of the staff and companies (Binder & Grimm, 2013), thus, directly linked to the laboratory animal's welfare. In addition, animal welfare is a fundamental condition for reliable study results (Baumans, 2005). For animal experimenters, Gärtner (1991) described two poles of empathy towards animals, one is the "kollektive, anonyme Beziehung" (p. 4) [collective anonymous relationship] the other one is the "Du-Evidenz" (p. 4) [you evidence]. Anonymity, avoidance of spontaneous contact and taking more concern on technical applications characterize the first pole, the second one individual knowledge, giving names and caretaking. However, usually no names are given to laboratory animals. Arluke (1988) found that laboratory animals usually are labeled with codes and long-used animals are more likely to principally bear a name, but often are not called by names. Gärtner (1985, cited by von den Driesch & Peters, 2003) showed that scientists have emotional reservations concerning of the killing of the laboratory animal whereupon rats and mice are attributed with the least need for protection. This leads to the question asked by Monamy (2009): "why is that a researcher can spend his or her weekend at home playing with a family pet and then, on Monday morning, return to their laboratory and test a potentially harmful chemical compound [...]? What is it about the donning of a white coat and the entering of the clinical atmosphere of a laboratory that can create an air of professional detachment?" (p. 5). The white coat of repression can be explained with the concept of deindividuation, which traditionally is defined as "a psychological state in which people lose their sense of personal identity and feel immersed in a group" (Breckler et al., 2005, p. 339). Moreover, "wearing clothes that make identification difficult (e.g. the same uniform as other people in a setting, or a costume that conceals one's identity) can heighten deindividuation" (Breckler et al., 2005, p. 339), thus, it "is hypothesized to "release" people from their normal ethical constraints" (Breckler et al., 2005, p. 339). Deindividuation seems to cause a form of transgression or a violation of one's own moral standards or norms. The individual apparently succumbs to the influence of a certain group or ideology. But deindividuation can also be interpreted as a normative behavior that does not necessarily entail the loss of individual personality

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(Vilanova et al., 2017).

The social identity model of deindividuation effects (SIDE) states "that anonymity does not produce a loss of identity so much as a switch to or an increase in the salience of social identity in group contexts" (Spears & Lea, 1994, p. 444). The classical definition of deindividuation as well as the controversial public debate on animal experimentation neglect the existence of group norms and practices that not only help animal experimenters to cope with potentially stressful events but also create a particular social identity. There is no strict dichotomy between the individual and the group because "the group can often be a source of support and strength, a means of resistance as well as a source of repression, quite literally as a part of the self" (Spears & Lea, 1994, p. 452). According to Reicher (1984, 1987; cited by Vilanova et al., 2017) group norms can "overlap with general social norms, even if they are incompatible" (p. 12). This is one reason why researchers may love their family pets and the same time are able to make experiments with laboratory animals. However, in the field of animal experiments, the coding of animals instead of giving names can be a tool for deindividuation as laboratory animals are only seen as data (Arluke, 1988). It has been proposed that the experimental setting is a stressful environment per se, particularly for individuals who have long-term relationships with laboratory animals (Arluke, 1988). It is therefore plausible that scientists have to develop a coping strategy over time to deal with that companion animal versus the-animal-as-object dichotomy as has been previously stated by Arluke (1988). Stiller & Stiller (1986) argued that animal experimenters frequently keep pets to compensate their feelings of guilt. Scientific evidence on animal experimenters' attitudes toward companion animals is however missing.

Lazarus defined 'coping as the cognitive and behavioral efforts a person makes to manage demands that tax or exceed his or her personal resources' (Lazarus & Folkman, 1984). In categorizing how people deal with stress, two major strategies have been described: 1) problem-focused coping and 2) emotion-focused coping. Individuals who focus on the problem become proactive and take steps to alleviate or change the subjective reality of the problematic situation. Emotion-focused strategies help to manage emotions associated with the stressful experience including avoidance and withdrawal but also reappraisal. However, the reality of the stressful situation remains unaffected (Lazarus & Folkman, 1984). This is in line with work by Scheier et al. (1986), stating different coping strategies in optimistic and pessimistic people. While optimistic people tend to use an approach-focused coping strategy such as the seeking of social support and tend to have positive aspects of the stressful situation in mind, pessimistic people tend to use a denial and distancing strategy with a focus on the negative aspects. Self-esteem is seen as one of four core constructs besides generalized self-efficacy, locus of control and emotional stability (low neuroticism) for job satisfaction and job performance (Judge & Bono, 2001). In 1986, Stiller & Stiller published a book called "Tierversuch und Tierexperimentator" [animal experiment and animal experimenter], based on their study on the personality of animal experimenters of 1976 which was highly criticized due to its harsh wording and unprofessional approach (Weihe, 1978). Stiller & Stiller (1986) suggested that animal experimenters have aggression towards the own person, compensated by invasive procedures on animals. Moreover, the killing of laboratory animals has been interpreted as a representative to overcome the own mortality. The authors concluded that a low self-esteem, an unconscious self-hate and the fear of the own mortality are representative traits for conducting animal experiments. To date, scientific data

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on personality traits of animal experimenters are lacking but a recent study suggested that researchers involved in animal experimentation have higher levels of state (not trait) anxiety when compared to non-animal experimenters (Kang et al., 2018). Facing the legal basis and need of animal experiments for human and veterinarian drug development even in the clinical setting (Fürdös et al., 2015), these divergent opinions have to be understood, harmonized and translated into best practice models.

Over the past decades, salivary cortisol (SC) has emerged as a frequently used biomarker for the study of stress-related activation of the hypothalamic-pituitary-adrenal (HPA) axis. Cortisol is a glucocorticoid hormone that is secreted in response to cascading arousal and exhibits a circadian rhythm with peaking levels in the morning and low concentrations in the evening in many diurnal mammal species including humans (Stone et al., 2001; Oster et al., 2017). Despite this characteristic secretion pattern, potent stressors can cause cortisol afternoon levels to rise above morning values (Glenk & Kothgassner, 2017). After usage instruction, saliva collection devices can be handled relatively easy and SC can be measured non-invasively.

Work-related stress, the development of coping strategies and psychometric variables such as self-esteem, pet attitude and personality traits may vary individually in animal experimenters but scientific evidence for this specific population is lacking. The original aim of this exploratory study was to investigate work-related stress in scientists who regularly perform invasive animal experiments. We sought to evaluate objective measures of stress (i.e. immediate SC responses and SC circadian rhythmicity) and subjective measures of coping with stress (i.e. how animal experimenters and their close social environment personally deal with animal experiments; how animal experimenters relieve stress) assessed in a semi-structured interview. Moreover, psychometric questionnaires to measure self-esteem, pet attitude and personality traits were applied to complement the physiological and interview data.

METHODS

Participants

Adult (≥ 25 years) university employed scientists with a completed professional education (no students), who had a minimum experience of two years with animal experimentation were currently conducting invasive experimental procedures on animals in Vienna were eligible for the study. As a first step, a convenience sample of potential candidates (N = 65) from three universities were contacted via email invitation, where a short overview on the study aims and conditions was given. Consumption of nicotine, coffee or sedative drugs was an exclusion criterion due to potential interferences with the HPA axis. Participation was voluntary and based on informed consent. Participants could withdraw from the study at any time without giving a reason.

Salivary cortisol

Saliva sampling was envisaged to be carried out on two days without animal experiments at four individually fixed time points (baseline) and on two days with animal experiments on the same four fixed time points to obtain patterns of circadian rhythmicity. In addition, to measure immediate responses to animal experimentation, participants were asked to collect a saliva sample 30 minutes before and 30 minutes after animal experimentation. As saliva samples should be taken as precisely as possible and differences in sampling should be

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avoided (Brom et al., 2014), the sampling schedule was set on four days; on two non-consecutive working days without any animal experiments at four fixed time points (i.e. morning: 09.00h; noon: 12.00h; afternoon: 15.00h; evening: 18.00h) for getting a baseline and on two non-consecutive working days with animal experiments at the same four fixed time points. To this end, individuals served as their own control, in that salivary cortisol profiles were determined for two conditions: laboratory work with and without invasive animal experiments.

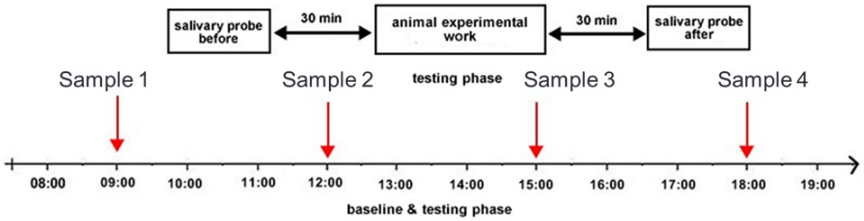

Figure 1. Saliva sampling schedule: Saliva samples (S1-S4) were collected on two days with animal experiments (testing phase) and two days without animal experiments (baseline) to assess circadian rhythmicity. Acute SC responses to animal experimentation were assessed by samples 30 minutes before and 30 after an experiment.

After a short introduction on how to collect saliva, participants were asked to sample their own saliva by using a set of pre-coded sampling devices (Salivette®, 51.1534, Sarstedt, Wiener Neudorf, Austria) and protocols to document saliva sampling time points. Saliva samples were stored in the freezer at the Department of Comparative Medicine at -20° Celsius. After thawing, the samples were centrifuged at 2500 g for 15 minutes and aliquots of 50 µl were analyzed via a cortisol enzyme immunoassay (EIA; Palme & Möstl, 1997) as previously described by Brom et al. (2014).

Interview

A semi-structured interview based on open-ended questions was conducted to investigate individual coping with animal experimentation-related stress. Emphasis was given on how researchers deal with animal experimentation personally and how their social environment (i.e. family and friends) reacts towards the topic. In addition, respondents were inquired how they tend to release stress. The interview protocol is provided in the appendix.

Psychometrics

Participants were asked to complete three psychological questionnaires. The Rosenberg Self-Esteem Scale (Rosenberg-SES) which measures self-esteem with an internal consistency between $\alpha = 0.77$ and $\alpha = 0.88$, and a retest reliability between $r = .82$ and $r = .88$ (Rosenberg, 1989). The Pet Attitude Scale (PAS) measures the attitude towards companion animals. Its internal consistency is $\alpha = 0.93$, the retest reliability is $r = 0.92$ and takes about five minutes (Templer & Arikawa, 2011). For the purpose of the study, the German version (Stetina & Lederman-Maman, 2005) of this questionnaire was chosen. The NEO- Five-Factor Inventory (NEO-FFI): The NEO-FFI measures the main 'Big Five' personality dimensions (Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience). Its internal consistency ranges between $\alpha = 0.72$ and $\alpha = 0.87$ and the retest reliability between $r = 0.71$ and $r = 0.82$ (Borkenau & Ostendorf, 2008).

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Ethical statement

The research proposal has been approved by the Ethics Committee of the Medical University Vienna has approved the study design (EK Nr: 1121/2014). All participants eligible for the study were conducting animal experiments that were already approved by the respective Ethics Committee. Hence, no further animal experiments needed to be scheduled for the present study, therefore, an ethical application according to the Animal Health and Welfare Act was not necessary.

RESULTS

Participation

A number of initially 65 potential participants was approached, of which 10 people (response rate 15.4%) declared an interest to participate. Consequently, an information meeting was organized, in which the candidates were provided with an informed consent form to sign and additional information on the study prerequisites. After the meeting, two participants cancelled their participation and eight participants started with data collection. During the sampling process four participants quit and four participants (6.15%) finished the whole sampling protocol (see Figure 1). Finally, the participants were three females and one male with a mean age of Mn = 44.25 (SD = 5.9) years. As participants could withdraw at any point during the study and without any further explanation, the reasons for drop out are unknown.

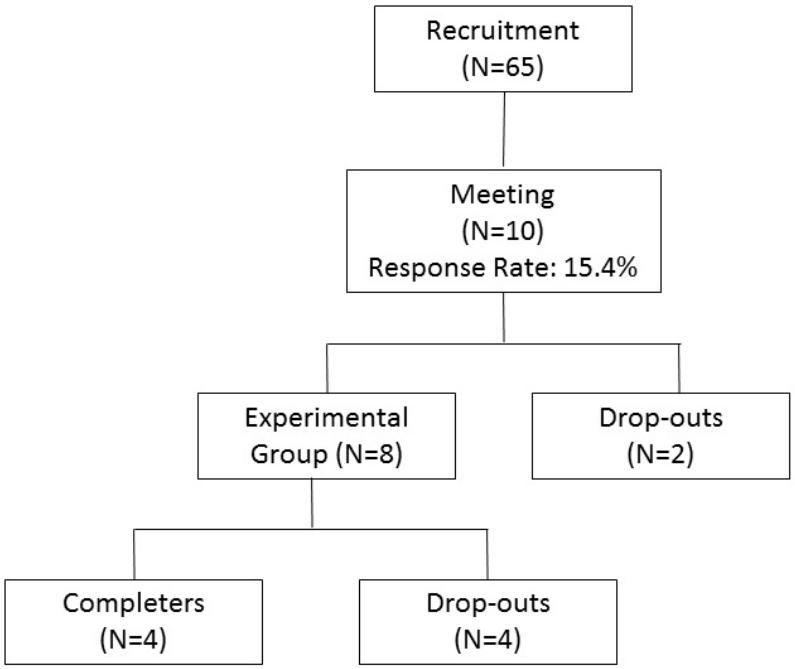

Figure 2. Overview on potential candidates who were invited via email recruitment, response rate and further participation. Calculation of the response rate: Ratio of Respones/Ratio of Requests * 100.

Apparently, the number of people volunteering for the study was too low to conduct any statistical analysis. However, the seemingly low willingness of researchers to participate in the study led us to elaborate theoretically on their potential reservations (see discussion).

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Salivary cortisol

There was a high variability in the duration of the animal experiments with the shortest duration being 1 h 15 min and the longest 4 h 15 min (see Table 1). Of note, Participant 2 failed to provide the pre-experimental sample on day 2 and Participant 3 failed to provide the post-experimental sample on day 1. Procedures included blood sampling, injections, removal of organs, tissue isolation, sacrifice and non-further specified applications. As demonstrated in Figure 3a and 3c, in two participants increased cortisol levels towards the evening on working days with animal experiments were found, while no increase on control days without animal experiments was detectable. This pattern of elevated evening cortisol levels on working days with animal experiments was absent in the other two participants (Figure 3b and 3d).

	Sample collection	Before A.E.	After A.E.	Δ SC	A.E. Duration
Participant 1	Day 3	Time: 07:30h SC: 48.7 ng/ml	Time: 08:45h SC: 22.7 ng/ml	-26 ng/ml	1h 15 min
	Day 4	Time: 09:00 SC: 23.3 ng/ml	Time: 10:30h SC: 20.8 ng/ml	-2.5 ng/ml	1h 30 min
Participant 2	Day 3	Time: 8:30h SC: 40.6 ng/ml	Time: 12:45h SC: 10.3 ng/ml	-30.3 ng/ml	4h 15 min
	Day 4	-	Time: 12:00h SC: 09.00 ng/ml	-	-
Participant 3	Day 3	Time: 08:15h SC: 60.0 ng/ml	-	-	-
	Day 4	Time: 12:05h SC: 12.3 ng/ml	Time: 14:15h SC: 06.5 ng/ml	-5.8 ng/ml	2h 10 min
Participant 4	Day 3	Time: 06:45h SC: 97.1 ng/ml	Time: 08:00h SC: 45.0 ng/ml	-52.1 ng/ml	1h 15 min
	Day 4	Time: 08:30h SC: 37.6 ng/ml	Time: 10:45h SC:16.2 ng/ml	-21.4 ng/ml	2h 15 min

Table 1. Overview on working days (Days 3+4) with animal experiments (AE), time of sampling, duration of the experiment and pre-/post SC levels.

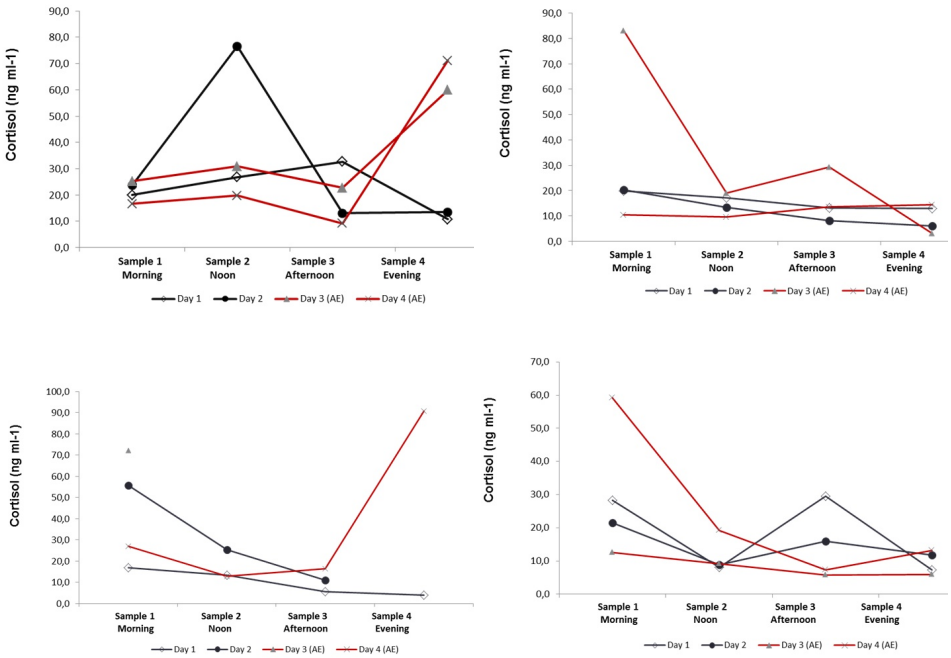

Figure 3a-d: Circadian salivary cortisol profiles of participants 1-4 on working days without (Day 1-2) and with animal experiments (AE; Day 3-4)

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Interview

Responses to how researchers personally cope with animal experimentation, how they perceive their social environment to deal with their work, and how they release work-related stress are presented in Table 2.

Participants	*Personal coping*	*Social environment*	*Stress reduction*
1	Meaningfulness of the experiments	Similar working environment	Activity
2	Handling animals in a responsible manner, performing experiments with colleagues	Reactions vary from "understanding" to "avoidant"	Activity, Engaging with family
3	Performing experiments with colleagues	Supportive	Activity
4	Handling animals in a responsible manner, performing experiments with colleagues	Interested but skeptical	Activity

Table 2: Semi-structured interview results on personal coping, perception of the social environment and stress reduction strategies of animal experimenters (N = 4).

The outcomes of the interview suggested several relevant coping mechanisms in dealing with work-related stress. A common strategy was seeking social support i.e. "performing experiments with colleagues" as stated by three respondents. It also emerged, that two researchers dealt with the procedures by stating that they would handle the animals in a responsible manner. The meaningfulness of the experiments per se in personally dealing with animal experimentation was mentioned by one person. When asked about how the close social environment dealt with their work, answers ranged from supportive and understanding to avoidant and skeptical. One person stated that socially close individuals performed similar work. When asked how individuals reduce stress arising from work-related procedures all respondents mentioned active leisure time including activities such as "sports", "dancing", "gardening". In contrast, only one person mentioned interaction with the family as a strategy to release stress. It also became apparent that participants used cognitive strategies as legitimization. Relevant statements of participants were:

"I treat every animal ethically, including dead animals"

"Professional handling is obligatory to reduce the burden as much as possible"

"If I'm convinced of the experimental test, I have no problems of justifying it to myself. Otherwise I wouldn't do it!".

Questionnaires

Table 3 shows that animal experimenters' SES-scores ranged from 31 to 36. Three participants scored 76-82 on the PAS scale. Participant 2 did not answer two questions and thereby reached a score of 69. The 'Neuroticism' subscale of the NEO-FFI inventory exhibited the highest variability between the participants, yielding scores between 8.5 and 83.9. The 'Extraversion' subscale of the NEO-FFI was marked by less variability with two identical scores of 42.2 and two scores ranging from 81.6 to 86. Three participants reached high scores (>90) on the 'Openness to Experience' subscale of the NEO-FFI whereas one participant scored 52.3. Again, three participants reached high scores (>90) on the 'Agreeableness' subscale of the NEO-FFI, while one participant 3 scored 34.6. Scores on the 'Conscientiousness' subscale of the NEO-FFI ranged from 77.3-99.1.

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	SES[1]	PAS[2]	NEO-FFI[3]				
			Neuroticism	Extraversion	Openness to Experience	Agreeableness	Conscientiousness
Participant 1	33	82	83.9	42.2	92.4	96.7	91.7
Participant 2	33	69[4]	8.5	42.2	52.3	99.9	99.1
Participant 3	31	78	40.6	81.6	98.3	34.6	77.3
Participant 4	36	76	29.9	86.0	97.6	96.7	82.4

[1] Maximum value: 50; [2] Maximum value: 126; [3] Maximum value: 100; [4] Participant 2 did not answer two items

Table 3. Sum scores of the psychological questionnaires: NEO-FFI (personality dimensions neuroticism, extraversion, openness to experience, agreeableness and conscientiousness), SES (self-esteem) and PAS (pet attitude) scale

DISCUSSION

The primary aim of study was to assess work-related stress academic researchers who are involved in invasive animal experimentation by gathering objective (i.e. salivary cortisol) and subjective (i.e. personal interview on coping; SES, PAS and NEO-FFI questionnaires) indicators. Apparently, only a small number of invited researchers (15.4%) declared an interest to participate and after a further informative meeting, eight people considered participation of which however only four individuals (6.15%) completed the whole protocol. It would have been interesting to investigate individual responses with regard to the lack of interest to participate. However, in line with the ethics statement, researchers were free to withdraw from the study without giving a reason. The high number of non-responders may be linked to tight working schedules associated with experimental research that did not allow for any extra time consuming procedures such as the sampling of saliva and completion of protocols. In addition, the public debate and controversy linked to animal experimentation could have accounted for the low study acceptance. The results from the interview again underline this controversy as researchers perceive their close social environment supportive and understanding on the one hand and avoidant to skeptical on the other hand. People working with laboratory animals have learned to live with the necessity of sacrificing animals to scientific ends. For them it is part of a socialization process to accept this ambivalence: "They learn to separate victim from pet, head from heart, and to live with the ambivalence of sacrifice as 'just part of the job'" (Arluke, 1988, p. 115). By contrast, "lay people often are puzzled by and suspicious of researchers who claim that they are compassionate and empathetic toward their laboratory animals" (ibid., p. 116). But laboratory research and public opinion about animal experimentation depend on distinct social norms, practices and ideals (at least in part). Yet researchers have to morally justify their experiments in a way that takes account of an increasing public interest on the topic. According to Arluke (1988), animal experimenters are not necessarily "riddled by conflict" (p. 116) or "torn by contradiction" (ibid.) even though they may have ambivalent feelings about their work or sometimes experience stress when experimenting on animals that are sympathetic to them. As pointed out by Holmberg & Ideland (2012) in their 'selective openness' model, animal experimenters rely on the public acceptance and are simultaneously urged to maintain secrecy in order not to get into conflict with opponents. Therefore, the seemingly limited willingness of researchers to participate in the study is an

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important result by itself. As described in the introduction, deindividuation is a self-protective mechanism that involves immersion in a group but the protocol of this study was clearly centered on the individual stress experience. Refusing to participate in a study on individual stress coping may (implicitely) help animal experimenters to maintain a state of deindividuation as animal experimentation per se is like a public stigma. Having accepted animal experiments as a part of their lives, experienced animal experimenters may not want to reflect on the uncomfortable aspects of their work and aspects of ambivalence over again. As suggested by the social identity and deindividuation model (Spears & Lea, 1994), it is likely that researchers working in the field of animal experimentation are oriented toward group norms that may be in conflict or overlap with other social norms (Vilanova et al., 2017). Seemingly conflicting norms can coexist with the public approving experiments in order to achieve medical advances while condemning those who perform the experiments. The semi-structured interview revealed that in dealing with animal experimentation and stress, researchers used coping strategies such as actively seeking social support from colleagues. In addition, researchers also mentioned that respectful and professional handling of laboratory animals helped them to deal with the experiments. These findings indicate an optimistic, problem-focused coping strategy to alleviate work-related stress (Rabenu & Yaniv, 2017). In addition, professional handling in line with animal welfare has been proposed as a legitimate agenda during the standardized education process of future animal experimenters (Holmberg, 2008). There was no evidence of avoidance-focused stress coping in any of the study respondents. Emotion-focused strategies such as considering the 'meaningfulness of the experiments' and during reappraisal of the conflicting situation was prevalent. Cognitive strategies for legitimization towards the use and sacrifice of laboratory animals were identified. Stress reduction strategies were creating active leisure time including common activities like sports, gardening or engaging with the family. The questionnaire data results indicate that self-esteem scores of three study participants were clearly above the average mean value of the SES scale (i.e. 31.78) that was previously reported in an Austrian population of 466 individuals (Schmitt & Allik, 2005). Self-esteem is important for a well-balanced job performance (Baumeister et al., 2003). All SES scores (ranging from 31-36) were substantially higher than the theoretical midpoint of the scale (i.e. 25), therefore, our findings contrast Stiller & Stiller's (1986) suggestion of a low self-esteem in animal experimenters. Results from the PAS demonstrated that all animal experimenters scored clearly higher than the theoretical midpoint of the scale (i.e. 63), indicating a moderately positive attitude towards pets. Thus, animal experimentation does not necessarily seem to come along with a negative attitude towards companion animals. Responses from this study's participants were comparable to scores of American non-vegetarian adults (Dixon Preylo & Arikawa, 2008). Personality scores indicate a high variability between the study respondents for 'neuroticism', with one person reaching a particular high score. Neuroticism has been linked with an impaired ability to cope with stress and is considered an important risk factor for stress-related mental disorders (Mohiyeddin et al., 2015; Uliaszek et al., 2010). Two individuals scored high on 'extraversion' and the other two participants had close-to-medium scores. Low extraversion has been linked with phobia and chronic life stress (Uliaszek et al., 2010). The dimensions 'openness to experience', 'agreeableness' and 'conscientiousness' led to high scores (≤ 82.4) in three out of four participants. The personality trait openness to experience has been related to health, linking adaptive cardiovascular stress responses with high scores on the scale (O'Súilleabháin et al., 2018). High agreeableness has been proposed a personality characteristic that may reduce

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Andreas Aigner,
Erika Jensen-Jarolim.

the risk for selecting environments that contribute to the occurrence of stressful events (Iacovino et al., 2017). Another study suggested that higher levels of 'extraversion', 'conscientiousness', 'openness to experience' and lower levels of 'neuroticism' corresponded to less stressor-related negative affect (Leger et al., 2016). The personality scores of the scientists in this study point at a merely adaptive constitution of traits referring to stress coping. The preliminary findings on SC revealed some interesting perspectives that warrant further study. The lack of an immediate increase in SC levels directly after animal experimentation suggests that researchers did not experience an acute stress response while performing the experiments. However, the study outcomes indicated that SC concentrations of two participants (of which one person failed to provide one saliva sample on day 2 and three saliva samples on day 3) were considerably increased towards the evening on working days with animal experimentation compared working days without animal studies. This pattern points at a dysregulated circadian rhythmicity, which has the potential to exert profound negative effects on overall health. Prolonged disruption in circadian rhythmicity has been associated with adverse effects on immunity, cardiovascular and metabolic health as well as increased disease susceptibility (Oster et al., 2017). An ineffective circadian cortisol rhythm (i.e. a flattened slope) has even been linked to poor survival rates in severely diseased individuals (Glenk & Kothgassner, 2017). Given the normal patterns of SC rhythmicity on each of the control days available in participant 1 and 3, the observed misalignment may be of temporary nature and thus, detrimental effects on health seem very unlikely.

Limitations of the study

During the phase of participant recruitment, in which we aimed to assess the willingness of scientists to investigate their level of arousal linked to the performance of invasive animal experiments, there was an overall limited interest for researchers to participate. Among the individuals who volunteered to take part, we were confronted with a high drop-out rate. However, these aspects are possibly the most important result and an indicator of the stigma of animal experimenters in the current debate. The generalizability of the present findings is certainly limited by the small sample of study participants that were willing to complete the protocol and as a result, no statistical analyses were performed.

Future directions

Future investigations may focus on the applicability of the theoretical concept of deindividuation. There is also a need for more theoretical and interdisciplinary research to answer on how a scientist can be professional, respectful and empathic at the same time (Grimm & Binder, 2013). To increase the compliance of future participants, shifting away from the stress induction focus toward investigation of indicators related to well-being could be helpful. Even if a change in research methodology would not necessarily be required, researchers may have been more willing to enroll in the study that is centered on their well-being rather than their stress-related working experience. Potential stress-mediating effects of cultural affiliation and religion in animal experimenters should also be envisaged in future research (Ormandy & Schuppli, 2014).

Accounting for the present findings of high levels of evening SC on working days with animal experimentation, future research may target circadian rhythm and mental health in animal experimenters on a broader scale. Our study participants were instructed to collect saliva on their own but considering the level of non-response, drop-out and the loss of saliva samples, it might have

Pet Behaviour Science
open access journal

Pet Behaviour Science
2020, Vol. 9, 1 - 15
doi:10.21071/pbs.v0i9.12006

Lisa Maria Glenk,
Cornelia Belik,
Rupert Palme,
Andreas Aigner,
Erika Jensen-Jarolim.

been more appropriate to put an experimenter (i.e. study assistant) in charge for assistance with- and supervision of saliva sampling. Although saliva sampling is non-invasive and can be carried out relatively easy, some people may consider it difficult or disgusting as described by Brom et al. (2014) and thus, refuse to participate. In fact, one participant noted that the dental role for collecting the saliva was "just disgusting, it tastes dry and bland". Assistance in saliva collection by a previously trained experimenter may have also elevated the compliance of study participants and motivated them to participate in the first place. As the study participants worked in different research groups and institutes with different and very strict working schedules, identification of similar time points for collecting saliva samples was challenging. We suggest that saliva collection schedules that allow between-individual comparisons during multi-staff experiments or sampling during a training course with several participants would be more efficient and may thus be considered in continuative research. Only experienced researchers who were university employees and regularly performing invasive animal experiments took part in this study but there is evidence that levels of anxiety are higher in younger and less experienced researchers (Kang et al. 2018). Therefore, future studies could take into account the amount of experience in animal experimentation and the willingness to perform animal experiments. Therefore, a comparison of individuals (divided into those who had just recently started to carry out animal experiments and long-term experienced ones) who currently perform animal experiments with those who have (at some point) quitted with animal experiments could yield additional insights into how work-related stress develops over time. It would be particularly interesting to investigate whether coping strategies of long-experienced researchers and those who are new to the procedures differ.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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Pet Behaviour Science
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Pet Behaviour Science
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