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You can't always remember what you want: The role of cortisol in self-ascription of assigned goals

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ABSTRACT

Past work indicates that persistent stress leads people to misremember assigned tasks as self-selected, a phenomenon known as self-infiltration [Baumann, N., & Kuhl, J. (2003). Self-infiltration: Confusing assigned tasks as self-selected in memory. *Personality and Social Psychology Bulletin, 29*, 487–497; Kazén, M., Baumann, N., & Kuhl, J. (2003). Self-infiltration vs. self-compatibility checking in dealing with unattractive tasks and unpleasant items: The moderating influence of state vs. action-orientation. *Motivation & Emotion, 27*, 157–197; Kuhl, J., & Kazén, M. (1994). Self-discrimination and memory: State orientation and false-self-ascription of assigned activities. *Journal of Personality & Social Psychology, 66*, 1103–1115]. The present research examined the link between self-infiltration and cortisol, a well-established stress hormone. Participants selected simple office tasks for later enactment and were assigned to do an additional set of office tasks by an instructor. After an 8-min stress induction, participants were unexpectedly asked to recognize which tasks were self-selected or assigned. Cortisol was assessed before and after the stress induction. As expected, self-infiltration was predicted both by pre- and by post-manipulation cortisol levels. These results point to some of the neuroendocrine functions that underlie the self.

1. Introduction

Several years ago, one of the authors of this article knew a young man who was destined by his parents to run the family business, a large manufacturing company. After completing his studies, the young man started to work in the family company, convinced that he himself chose this profession. However, within a few months' time, the young man became burned out in his job. After a year of soul-searching, the young man decided to try his luck elsewhere, and began a successful career in acting.

Conflicts between personal desires and the demands of social environment are an inevitable aspect of social life. People are often acutely aware of these conflicts but may nevertheless adapt their goals to external demands, or "introject" imposed goals (Deci & Ryan, 2002). At times, however, individuals may lose sight of the precise origins of their goals and consider it freely chosen, even when the goal in question is not fully integrated into the self. The process whereby external goals, expectations, standards, and values become introjected into the self without the individual's awareness of the self-alien nature of the goal is known as *self-infiltration* (Kuhl & Kazén, 1994). Self-infiltration processes are of fundamental interest to social and personality psychologists, because they speak to the question how external demands become internalized (see Deci & Ryan, 2002; Moretti & Higgins, 1999). Moreover, self-infiltration is associated with reduced psychological well-being and poor physical health (Baumann, Kaschel, & Kuhl, 2005; Brunstein, Schultheiss, & Grässman, 1998). It is therefore important to improve our understanding of self-infiltration processes.

Our aim in the present research is to illuminate some of the neuroendocrine functions that underlie self-infiltration. In particular, we investigate the influence of cortisol release before and after a stress task on self-infiltration. Cortisol is one of the most widely investigated stress hormones (Dickerson & Kemeny, 2004). Because self-infiltration occurs especially under stress (Baumann & Kuhl, 2003; Kazén, Baumann, & Kuhl, 2003), we suspect that cortisol might be associated with self-infiltration. In the next paragraphs, we begin by reviewing previous work on self-infiltration. After this, we consider the theoretical rationale for linking cortisol to self-infiltration. Finally, we present a study that empirically addressed the association between cortisol release and self-infiltration.

The study of personal goals has traditionally relied heavily on self-report measures (e.g., Brunstein et al., 1998; Sheldon,

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Williams, & Joiner, 2003). Although self-report measures are an important source of information, they are less suitable to the study of self-infiltration processes. This is because self-infiltration by definition implies that individuals are confused about the true source of their goals. It is thus necessary to use indirect or implicit measures to investigate self-infiltration. Implicit measures avoid asking individuals directly about their psychological responses, and are increasingly used in social and personality psychology (Greenwald & Banaji, 1995; Koole & DeHart, 2007).

In a pioneering set of studies, Kuhl and Kazén (1994) developed an indirect method to assess self-infiltration processes, the so-called "self-discrimination task". In the self-discrimination task participants are asked to select a certain number of tasks from a list that are to be performed out later on in the experiment. In addition, participants are also assigned by the experimenter to perform certain tasks from the list. Finally, some tasks on the list are neither self-selected nor assigned. In an unexpected memory retrieval test, participants are later asked about the initial *source* of each task, whether it was self-selected, assigned, or neither. The rate of tasks that are self-ascribed but originally assigned by the experimenter is taken as an index of self-infiltration.

Kuhl and associates have theorized that self-infiltration is particularly likely to occur under persistent stress (Kuhl, 1992, 2000, 2001). The basic idea is that persistent stress blocks people's ability to retrieve integrated self-representations. In line with this reasoning, Kuhl and Kazén (1994) found in two experiments that individuals with an impaired ability to downregulate stressful affect, so-called "state-oriented" individuals (Kuhl & Beckmann, 1994), showed higher levels of self-infiltration than individuals who are efficient at down-regulating stressful affect, so-called "action-oriented" individuals. Baumann and Kuhl (2003) replicated and extended these findings, by showing that state-oriented individuals differ from action-oriented individuals in the level of self-infiltration only when stressful affect is high rather than low. This effect was found both for self-reported (Study 1) and experimentally induced (Study 2) stressful emotion. The stress-dependent nature of self-infiltration was replicated by Kazén et al. (2003) in two additional experiments.

Using the self-discrimination task, Kazén et al. (2003) showed that self-infiltration occurred for low attractive but not high attractive items. This finding supports the notion that the self-infiltration task does not tap into identification tendencies. Identification is an adaptive process whereby individuals integrate new goals into the self (Deci & Ryan, 2002). Identification processes operate especially when new goals are attractive to the person. Thus, if state-oriented individuals confuse assigned goals as self-selected because of their enhanced identification with assigned goals, one would expect state-oriented individuals to misremember assigned goals as self-selected more when the assigned goals are attractive as opposed to unattractive, after controlling for memory guessing. In fact, the opposite pattern occurred among state-oriented individuals. The self-discrimination task thus taps into introjection rather than identification processes.

To date, no study has yet directly investigated a possible relationship between self-infiltration and endocrine functioning. Nevertheless, Baumann et al. (2005) found suggestive evidence of such a relationship. Baumann, Kaschel, et al. measured self-infiltration indirectly, by assessing the congruency between goals and emotional needs. When people's goals do not match their emotional needs, they choose goals with low intrinsic value to the self. The presence of goal-need discrepancies is therefore a sign of self-infiltration processes. In line with this reasoning, Baumann, Kaschel, et al. found that goal-need discrepancies are enhanced under the same conditions as self-infiltration, i.e., among state-oriented individuals with high levels of stress. Notably, goal-need discrepancies were correlated with increases in physical symptoms (e.g., back and stomach aches). These findings are relevant to the present research, in that stress-contingent cortisol dysregulation contributes to the development and continuation of physical diseases (McEwen, 1998).

Cortisol is a glucocorticoid hormone released into the blood stream by the adrenal glands as a reaction to a cascade of transmitter processes involved in the hypothalamic–pituitary–adrenal (HPA) system (e.g., Lovallo & Thomas, 2000). Specifically, through hypothalamic release of corticotropin releasing hormone (CRH) which in turn stimulates the pituitary gland to release adrenocorticotropic hormone (ACTH). Finally, ACTH stimulates release of cortisol from the adrenal glands into the blood stream, which by itself down-regulates HPA system activation in a negative feedback loop. Activity of the HPA system increases in reaction to a broad spectrum of threats. A recent meta-analysis found that HPA system is strongly activated by stressors that threaten the social self, for instance, threats to social acceptance or self-esteem (Dickerson & Kemeny, 2004; Gruenewald, Kemeny, Aziz, & Fahey, 2004). The meta-analysis also found that the HPA system becomes activated in response to uncontrollable stressors (see also Biondi & Picardi, 1999; Mason, 1968), although this effect was smaller than that of social threat. For example, exposure to uncontrollable noise has been found to increase HPA activity (e.g., Bollini, Walker, Hamann, & Kestler, 2004).

Prolonged phases of negative affect can result in persistent cortisol dysregulation, which is in turn associated with a number of negative health outcomes. For example, cortisol dysregulation is associated with chronic stress, depressive symptoms, posttraumatic stress, reduced hippocampal volume, and psychosomatic diseases (e.g., Herman, Ostrander, Mueller, & Figueiredo, 2005; McEwen, 1998). Cortisol dysregulations have also been observed for individuals with personality traits such as low autonomy or self-esteem (e.g., Bollini et al., 2004; Pruessner et al., 2005) or high attachment anxiety (Quirin, Pruessner, & Kuhl, 2008).

The present research was designed to investigate the link between cortisol release and self-infiltration. Both self-infiltration and cortisol have been found to increase under stress. It therefore stands to reason that cortisol may be empirically associated with self-infiltration. Establishing an empirical association between self-infiltration and cortisol would substantiate the theoretical notion of the influence of stress (or negative affect) on self-infiltration and would give rise to a discussion on potential neuroendocrine underpinnings of self-infiltration, a topic that has remained unaddressed in previous research. Not least, the investigation of this relationship would add to the interdisciplinary field of research on the link between biological and psychological processes in general.

To assess self-infiltration, we used the self-discrimination task (Baumann & Kuhl, 2003; Baumann, Kuhl, & Kazén, 2005; Kazén et al., 2003; Kuhl & Kazén, 1994). Because high task attractiveness increases the probability that individuals identify with externally-assigned tasks with the consequence that goal introjection and goal identification may be confounded (cf. Baumann & Kuhl, 2003; Kazén et al., 2003), we confined the experiment to tasks that were judged as low attractive in previous studies. Using only *low*-attractive items, false-self-ascriptions of assigned goals can be attributed to self-infiltration rather than identification processes (Baumann & Kuhl, 2003; Kazén et al., 2003).

To stimulate HPA arousal, participants were exposed to uncontrollable startle noises that were repeatedly applied via headphone while they performed on a visual-classification task. Salivary cortisol was assessed at the beginning of the experiment as a baseline, as well as 25 min after the onset of stress induction. Additionally, we measured participants' negative moods before and after the stress manipulation to establish the extent to which our findings were mediated by subjectively experienced stress.

Circadian cortisol secretion is typically influenced by stress levels individuals experience in their daily lives (Lovallo & Thomas, 2000). We therefore hypothesized that baseline cortisol would be positively associated with self-infiltration as indicated by an increased rate of *false-self-ascriptions* of assigned tasks compared to a baseline of remaining tasks that were neither self-selected nor assigned. In addition, we hypothesized that increases in cortisol would predict self-infiltration over and above baseline cortisol. However, because of the typical circadian decline in cortisol level, which may counteract stress-contingent cortisol increase, we were uncertain about whether or not a main effect of cortisol increase would appear.

2. Methods

2.1. Sample

Forty-eight women, aged 20–45 ($M = 33.9$, $SD = 8.4$), were recruited via newspaper announcements and received 20 Euro (about $25) in return for their participation. Previous research has revealed differences in HPA regulation between men and women in levels of free salivary cortisol (e.g., Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999). Therefore, recruiting both male and female participants would contribute to error variance in the present study. We thus considered to include only one gender in the study and decided for women.

Five participants were excluded from the analysis because of incomplete data. As assessed by self-report, none of the participants had a depressive or other psychiatric disorder. All participants were non-smokers. The present study was part of a larger project aimed at investigating the relations between personality, motivation, and cortisol release. Data concerning the relationship of adult attachment styles and related personality traits with stress-contingent cortisol changes are reported elsewhere (Quirin et al., 2008). Data regarding the relationship between cortisol measurements and self-infiltration are exclusively reported in the present paper. The two studies share data only with respect to overall changes in cortisol.

2.2. Materials

We assessed self-reported acute stress by the negative affect scale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; for the German version, see Krohne, Egloff, Kohlmann, & Tausch, 1996). In this instrument, participants are asked to rate their current affective states on a 5-point-Likert scale ranging from (1) very slightly or not at all to (5) extremely.[1]

To determine cortisol levels, saliva was sampled with small pads of cotton wool ("Salivates", Sarstedt). The pads had to be chewed until they were soaked with saliva. Cortisol was analyzed by a time-resolved immunoassay with fluorescence detection (for a detailed description, see Dressendörfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992).

2.3. Procedure

Prior to the experiment, participants were instructed to refrain from drinking alcohol, or using any other drugs on the day of the experiment. They were also required to not exercise, eat, drink (except water), or brush their teeth up to 2 h prior to participation. Each session took place at about 2 pm.

Participants were tested individually in small booths furnished with a desk, a chair, and a computer. Upon arrival, participants were informed that the session consisted of a series of independent studies relating to different research questions. Among these studies, one was concerned with the effects of work on hormonal reactions, which were to be measured with saliva samples. Participants were then instructed on how to use the salivates and delivered a first sample of saliva. This baseline measure (Time 1) was administered 20 min before the stressor. Cortisol levels at this time varied between 0.9 and 14.0 nmol/l. Thereafter, participants were introduced to the self-discrimination task (Kuhl & Kazén, 1994). Participants were given a list of 36 "mini-tasks" typically occurring in a working day of an office secretary. Participants were informed that the following procedure constitutes a simulation of an office working day. They were asked to select 12 tasks from the list for putative later enactment.

Some examples of the tasks that participants could select were: "writing labels on files", "sharpening pencils", "renewing the supply of paper clips", "looking up for telephone numbers", etc. In the original German version, each item consisted of two terms, a verb and an object. Subsequent to the self-selection, as a distraction, participants were asked to carry out some short tasks and relax until the experimenter returned. After 5 min, the experimenter re-entered the room and handed out the same list of tasks one more time. This time, however, twelve different tasks were marked and participants were asked to take note of them, because the "boss" wanted them to carry out these tasks as well. After these assignments, participants reported their affect on the PANAS, which was followed by a filler task of 5 min and the stress induction.

Because previous research suggests that extreme stress situations such as public speaking (Kirschbaum, Pirke, & Hellhammer, 1993) are less than optimal to reveal relationships between cortisol changes and psychological variables (e.g., Gerra et al., 2001; Pruessner et al., 1997), we decided to apply a moderate stressor. Specifically, participants received randomly applied *uncontrollable* and *unpredictable* auditory startles (500 ms, 102 db) 36 times over a period of 8 min during which participants carried out an unrelated visual-classification task. Participants neither knew when or how often the stressor would appear nor had any control over the stressor, once it occurred. Uncontrollability and unpredictability constitute psychological conditions that have been revealed to stimulate HPA activity in previous research (Dickerson & Kemeny, 2004; Mason, 1968).

Next, participants again completed the PANAS. The PANAS was followed by a 15-min period of filler tasks, which included the second cortisol assessment at 25 min after the onset of the stress task (peak). Cortisol levels at Time 2 varied between 1.7 and 14.5 nmol/l. Separating learning and testing of the office jobs by filler tasks weakens memory traces and thus raises the probability that participants make memory retrieval errors including false-self-ascriptions (Baumann & Kuhl, 2003; Kazén et al., 2003).

Memory for the source of the office tasks was tested in two different computerized tasks in which participants were exposed to each item appearing sequentially on the screen in random order. The tasks were preceded by the following story: "We now return to the simulation of the office day. An important aspect for the enactment of tasks is the ability to remember them. Therefore, we want to carry out a memory test now". In the self-classification task, participants had to decide whether the presented item was originally self-selected or not. In the other-classification task, participants had to decide whether the presented item was assigned to them by the boss (the experimenter) or not. The order of the classification tasks was counterbalanced between participants.

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[1] We also measured individual differences in threat-related action vs. state orientation using the action-control scale, a validated scale (Kuhl & Beckmann, 1994). This scale showed significant differences in self-infiltration in previous research. Threat-related action orientation refers to the ability to control maladaptive intrusive thoughts (brooding) and concomitant emotional responses to stressors. However, because we did not find any effects of action vs. state orientation in the present study, we decided not to report about data on action orientation.

2.4. Measures of memory performance

Participants' rates of *false-self-ascriptions* of assigned tasks were calculated as the percentage of activities assigned by the experimenter that the participant mistook as self-chosen. To control for general memory deficits, we subtracted the rates of false-self-ascriptions of remaining activities that were neither self-selected nor assigned from the rate of false-self-ascriptions of assigned tasks, following the usual procedure reported in the literature (Baumann & Kuhl, 2003; Kazén et al., 2003; Kuhl & Kazén, 1994). For the sake of brevity, we refer to the corrected rates of false-self-ascriptions of assigned items simply as "false-self-ascriptions".

A second way in which we controlled for global memory deficits processes was to consider participants' rates of false-other-ascriptions, that is, activities originally self-selected by the participant that he or she falsely classified as externally assigned. We corrected participants' rates of false-other-ascriptions of originally self-selected tasks for the rate of false-other-ascriptions of remaining activities that were neither self-selected nor assigned by subtracting the latter from the former values. For the sake of brevity, we refer to corrected rates of false-other-ascriptions of assigned items simply as "false-other-ascriptions". A significant relationship between cortisol and false-self-ascriptions rather than false-other-ascriptions would support the assumption that cortisol specifically reduces self-access as opposed to more global self-other discrimination abilities associated with source monitoring (cf. Johnson, 1988).

3. Results

To establish whether the stress induction resulted in more negative moods and increases in cortisol release, we conducted a series of paired *t*-tests. As expected, the stress induction led to a significant increase in negative affect from Time 1 ($M = 1.99$, $SD = 0.62$) to Time 2 ($M = 2.18$, $SD = 0.79$), $t(42) = -2.08$, $p < .05$. Unexpectedly, however, the stress induction did not lead to a significant change in cortisol from Time 1 to Time 2, although the means were in the predicted direction ($M = 5.30$ nmol/l, $SD = 3.14$ at Time 1; $M = 5.51$ nmol/l, $SD = 3.21$ at Time 2), $t(42) = -.79$, $p > .40$.

From the standpoint of experimental rigor, the variance in cortisol release in response to our stress manipulation may be considered undesirable. However, because the purpose of the present study was to investigate the correlation between cortisol increases and self-infiltration, having some variance in the effects of the stress manipulation was not necessarily problematic. Notably, if our manipulation has caused uniform increases in cortisol increase, the likelihood of finding significant correlations between cortisol release and external variables would have become smaller because of restriction of range. Indeed, a closer inspection of the data revealed that 51% of the participants displayed an increase in cortisol, whereas 49% of the entire sample displayed a decrease in cortisol. Although an increase in only half of the participants may not seem impressive, cortisol normally shows a continuous circadian decline (Lovallo & Thomas, 2000). Increases in cortisol at Time 2 as compared to Time 1 were thus likely due to stress rather than random variation. In any case, it is important to note that a sizable subgroup of our participants did display increases in cortisol levels in response to our stress manipulation, even though there was much variation in this effect. Accordingly, we proceeded with the analysis of the associations between our measures of cortisol and self-infiltration.

First, however, we analyzed means and SDs of the non-composed parameters of memory performance. On average, there were 82.0% of correct self-ascriptions ($SD = 18.0$), 16.2% of false-self-ascriptions of assigned tasks ($SD = 18.0$), 12.7% of false-self-ascriptions of remaining tasks ($SD = 14.1$), 62.5% of correct other-ascribed tasks ($SD = 30.5$), 34.9% of false-other-ascriptions of self-selected tasks ($SD = 30.8$), and 34.2% of false-other-ascriptions of remaining tasks ($SD = 27.8$). These rates are comparable to those reported in previous studies (e.g., Kuhl & Kazén, 1994, Exp. 1).

Next, we examined the correlations between memory performance, cortisol level, and negative affect. The results of this analysis are displayed in Table 1. Consistent with our hypotheses, false-self-ascriptions were positively correlated with cortisol levels at Time 1, $r(41) = .37$, $p < .05$. Moreover, false-self-ascriptions were even more strongly correlated with cortisol levels at Time 2, $r(41) = .58$, $p < .001$. Using a test that compares correlations from dependent samples (see Meng, Rosenthal, & Rubin, 1992), the two correlations were found to be significantly different from each other, $Z = -2.43$, $p < .01$. False-self-ascriptions were uncorrelated with the baseline-corrected rate of false-other-ascriptions, $r(41) = -.20$, ns. Thus, there was no indication that the self-infiltration measure was confounded with general deficits in self-other discrimination and overall memory performance.

Cortisol levels at Time 1 significantly correlated with cortisol levels at Time 2, suggesting high reliability of cortisol assessment during the experiment, $r(41) = .85$, $p < .001$. Because of the overlap in variance between cortisol levels at Time 1 and Time 2, it remained important to establish whether each cortisol measure explained unique variance in self-infiltration. To this end, we conducted hierarchical regression analyses. In the correlational analyses, for the sake of simplicity, false-self-ascriptions of assigned tasks were corrected by subtracting false-self-ascriptions of remaining tasks. By contrast, in the hierarchical regression analyses, we controlled for the latter variable by including it as a covariate among the set of predictors.

In the first hierarchical regression analysis, false-self-ascriptions of assigned tasks were used as a criterion. To test the effect of post-stress induction cortisol on false-self-ascriptions, pre-stress and post-stress cortisol levels were successively included as predictors. Results are shown in Table 2. Baseline cortisol at Time 1 significantly predicted false-self-ascriptions, $\Delta R^2 = .08$, $p < .05$.

Table 1
Correlations, means, and standard deviations for self-infiltration measures, cortisol, and negative affect before (Time 1) and after (Time 2) stress induction.

	FSA	FOA	Cort Time 1	Cort Time 2	NA pre	*M*	*SD*
FSA	–					3.49	16.53
FOA	−.20	–				0.67	45.48
Cortisol (Cort) Time 1	.37*	.05	–			5.30	3.14
Cortisol Time 2	.58***	.02	.85***	–		5.51	3.21
Negative affect (NA) Time 1	−.11	−.12	−.09	−.10	–	1.99	0.62
NA Time 2	−.04	.02	.09	.05	.77***	2.18	0.79

Note: FSA = false self-ascriptions. FOA = false other-ascriptions.

[*] $p < .05$.

[***] $p < .001$.

Table 2
Hierarchical regression analyses predicting false self-ascriptions and false other-ascriptions by cortisol release at Times 1 and 2.

Predictor	R^2	ΔR^2	ΔF
Regression on false-self-ascription of assigned tasks			
False-self-ascription of remaining tasks	.24	.24	12.94***
Cortisol at Time 1 (baseline)	.32	.08	4.98*
Cortisol at Time 2	.50	.12	13.88***
Regression on false-other-ascription of self-selected tasks			
False-other-ascription of remaining tasks	.04	.04	1.71
Cortisol at Time 1 (baseline)	.04	.00	0.04
Cortisol at Time 2	.11	.07	2.87

* $p < .05$.
*** $p < .001$.

Thus, participants' initial levels of cortisol were predictive of self-infiltration. Moreover, after controlling for baseline cortisol levels, cortisol level at Time 2 remained a significant predictor of false-self-ascriptions of assigned items, $\Delta R^2 = .12$, $p < .001$. Thus, stress-related cortisol release had an independent effect on self-infiltration, over and above the effect of baseline cortisol.

To examine whether negative affect had similar effects as cortisol, a parallel regression analysis was conducted on false-self-ascriptions of assigned items, with pre- and post-induction measures of negative affect as covariates. This analysis yielded no significant effects, $\Delta R^2 < .20$, ns. To control for the possibility that cortisol does not specifically affect self-infiltration but self-other discrimination in general, a further regression analysis was conducted on false-other-ascriptions of self-selected items as a criterion, controlling for false-other-ascriptions of remaining items. As can be seen in Table 2, there was no significant relationship between cortisol and false-other-ascriptions.

4. Discussion

The present study investigated the association between cortisol release and self-infiltration, or the tendency to falsely ascribe assigned goals to the self. Because past research has found that self-infiltration becomes enhanced under stress (Baumann & Kuhl, 2003; Kazén et al., 2003), we reasoned that cortisol as an endocrine stress marker should be positively associated with self-infiltration. Consistent with this, both initial levels of cortisol at the outset of the experiment and cortisol levels after a stress induction were significant predictors of self-infiltration as measured in the self-discrimination task (Kuhl & Kazén, 1994). These findings suggest that the relationship between stress and self-infiltration can be generalized to bodily stress markers such as cortisol. As far as we know, the present research is the first to establish a link between neuroendocrine functioning and self-infiltration.

Baseline and post-induction cortisol levels had independent associations with self-infiltration. This is in line with the idea that both circadian cortisol rhythms and acute cortisol increases to laboratory stress induction can be taken as endocrine stress indicators (Lovallo & Thomas, 2000). The independent contributions of baseline and post-induction cortisol levels suggest that each measure captured unique variation in stress. Baseline cortisol likely reflected some combination of real-life stress that people brought with them into the experiment, or stress induced by participating in the experiment itself. Post-induction cortisol likely reflected the degree to which participants had been stressed by the uncontrollable noise procedure. The present findings thus indicate that cortisol releases that are due to different types of stressors are each uniquely predictive of self-infiltration.

The stress manipulation did not show a general increase in cortisol. It is conceivable that the stressor applied in the present research was not intense enough for all participants to produce a main effect in cortisol secretion that counteracts the typical circadian decline (cf. Quirin et al., 2008). Even so, the independent effect of post-stress cortisol on self-infiltration found in the present study suggests that the stress induction stimulated HPA activation in at least a subgroup of individuals, which was strong enough to be meaningfully associated with self-infiltration.

An unexpected outcome was the lack of effects of negative mood on self-infiltration. One possibility is that people were unaware of the stress that led to higher rates of self-infiltration. Another possibility is that the absence of a relationship between experienced affect and self-infiltration was due to specific nature of the affect measure. Previous research on self-reported negative affect and self-infiltration used mood adjectives that were highly self-relevant such as sad, depressed, worried, anxious, or sorrowful (e.g., Baumann & Kuhl, 2003; Kazén et al., 2003). By contrast, the negative affect scale of the PANAS has items such as distressed, irritable, or nervous, which are less self-relevant but are associated with general arousal (cf. Pressman & Cohen, 2005). The distinction between self-relevant vs. arousal-related mood may be tested in future self-infiltration research.

The present research used a correlational design, so that the causal link between cortisol release and self-infiltration cannot completely be determined. On the basis of the temporal sequence of measurements in the study, it can be ruled out that acute self-infiltration effects influenced preceding cortisol changes. Nevertheless it remains possible that cortisol increase and self-infiltration were both influenced by an unknown third variable such as personality differences (though see Footnote 1) or any other component of the human stress response that has not been assessed in the present study. Future research may manipulate cortisol levels directly to examine a potential causal impact on self-infiltration (cf. Wolf, Witt, & Hellhammer, 2004).

Because the present research controlled for measures of memory performance, the present results cannot be explained in terms of general memory deficits, reduced working-memory capacity under stress (Johnson, 1988) or less systematic processing of source cues under stress. The results therefore suggest that cortisol does not influence memory performance or source monitoring per se but a specific aspect thereof, namely the tendency to misattribute assigned items as self-selected, which is in line with previous research on stress and self-access (Baumann & Kuhl, 2003; Kazén et al., 2003; Kuhl & Kazén, 1994).

Based on a large number of neurobiological studies, several authors have suggested that the psychological self is supported by a distinct neurobiological system (e.g., Conway et al., 1999; Keenan, Nelson, O'Connor, & Pascual-Leone, 2001; Platek, Keenan, Gallup, & Mohamed, 2004; though see Gillihan & Farah, 2005). The present finding that cortisol facilitates misremembering other's goals as self-selected but not vice versa is congruent with the notion of the self as a special system and the notion of a close association between social self threats and cortisol release (Dickerson & Kemeny, 2004; Gruenewald et al., 2004). By revealing influences of cortisol on self-infiltration the present study provides initial evidence that the relationship between the social self and cortisol secretion may be considered to be bidirectional. Specifically, it may be speculated whether cortisol secretion has a distinct effect not only on self-infiltration processes but on cognitions and emotions associated with the social self in general, such as self-esteem or self-determination. Indeed, relationships between baseline cortisol and self-esteem or subjective autonomy have been reported (e.g., Pruessner, Hellhammer, & Kirschbaum, 1999; Pruessner, Lord, Meaney, & Lupien, 2004; Pruessner et al., 2005), whereas relationships between personality variables unrelated to the self such as extraversion and neuroticism have not been found (e.g., Engström, Westrin, Ekman, & Traskman-Bendz, 1999; Miller, Cohen, Rabin, Skoner, & Doyle, 1999; Roy, 1996; Schommer, Kudielka, Hellhammer, & Kirschbaum, 1999). Although we do not question that cortisol has effects on general episodic and autobiographic memory performance (cf. Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; Wolf et al., 2004), the present results suggest that cortisol may have a more pronounced influence on self-referential memory traces.

A theory that can place the present findings into a broader theoretical context is personality systems interactions (PSI) theory (Kuhl, 2000, 2001; see also Quirin & Kuhl, 2006). PSI theory accords central significance to the hippocampus as a subcortical system supporting the operating of the self (Kuhl, 2000, 2001). The hippocampus is known to support both encoding and retrieval of episodic memory by instantaneously integrating myriads of episodic information into coherent autobiographic representations (Lepage, Habib, & Tulving, 1998). Particularly, the hippocampus differentiates information that is relevant to the self, whereas it compresses information that is less relevant to the self (Gluck & Myers, 2001). Whereas the hippocampus is inhibited under high levels of cortisol (McEwen & Sapolsky, 1995), at the same time, the hippocampus down-regulates activity of the HPA system and concomitant cortisol release (Herman et al., 2005). The interaction between hippocampus and HPA system parallels the reciprocal inhibitory relationships postulated between the self and negative affect in PSI theory. Because cortisol has a detrimental influence on hippocampal functioning when above a critical threshold, integrated self-representations may not be processed any longer in an appropriate manner.

It has been speculated that individual differences in threat-related state orientation, which refers to the inability to control maladaptive intrusive thoughts (brooding) and concomitant emotional responses to stressors, may show reduced hippocampal functioning during stress (Kuhl, 2000). As mentioned above, threat-related state orientation was significantly related to high rates of self-infiltration after negative affect in previous research. To demonstrate the relevance of the present research for individual differences, future research may investigate the role of state orientation (or rumination) in moderating the present effects using affect inductions that are sensitive to provoke different effects for individuals high vs. low in state orientation.

In closing, it is worth pointing out that the present findings may have important implications for everyday behavior and well-being. When access to personal goals is reduced by stress for the benefit of alien goals, an individuals' possibility to make a free choice, that is to be autonomous and self-determined, is impaired (Deci & Ryan, 2002), as illustrated by our story of the young man whose parents guided him towards a career that did not fit with his personal preferences. Individuals with low levels of autonomy or self-integration of goals suffer from reduced well-being and life satisfaction (Deci & Ryan, 2002) and increased physical symptoms (Baumann et al., 2005). The present research demonstrates that stress-contingent HPA activity is associated with an inhibition of integrated self-representations and with an introjection of other individuals' goals. Therefore, the present research points to a potential connection between neuroendocrine processes and the self and adds to the literature on a link between biological and psychological processes.

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References

Baumann, N., Kaschel, R., & Kuhl, J. (2005). Striving for unwanted goals: Stress-dependent discrepancies between explicit and implicit achievement motives reduce subjective well-being and increase psychosomatic symptoms. *Journal of Personality and Social Psychology, 89*, 781–799.

Baumann, N., & Kuhl, J. (2003). Self-infiltration: Confusing assigned tasks as self-selected in memory. *Personality and Social Psychology Bulletin, 29*, 487–497.

Baumann, N., Kuhl, J., & Kazén, M. (2005). Left-hemispheric activation and self-infiltration: Testing a neuropsychological model of internalization. *Motivation and Emotion, 29*, 135–163.

Biondi, M., & Picardi, A. (1999). Psychological stress and neuroendocrine function in humans: The last two decades of research. *Psychotherapy and Psychosomatics, 68*, 114–150.

Bollini, A. M., Walker, E. F., Hamann, S., & Kestler, L. (2004). The influence of perceived control and locus of control on the cortisol and subjective responses to stress. *Biological Psychology, 67*, 245–260.

Brunstein, J. C., Schultheiss, O. C., & Grässman, R. (1998). Personal goals and emotional well-being: The moderating role of motive dispositions. *Journal of Personality & Social Psychology, 75*, 494–508.

Conway, M. A., Turk, D. J., Miller, S. L., Logan, J., Nebes, R. D., Meltzer, C. C., et al. (1999). A positron emission tomography (PET) study of autobiographical memory retrieval. *Memory, 7*, 679–702.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester: University of Rochester Press.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*, 355–391.

Dressendörfer, R. A., Kirschbaum, C., Rohde, W., Stahl, F., & Strasburger, C. J. (1992). Synthesis of a cortisol-biotin conjugate and evaluation as a tracer in an immunoassay for salivary cortisol measurement. *Journal of Steroid Biochemistry and Molecular Biology, 43*, 683–692.

Engström, G., Westrin, A., Ekman, R., & Traskman-Bendz, L. (1999). Relationships between CSF neuropeptides and temperament traits in suicide attempters. *Personality and Individual Differences, 26*, 13–19.

Gerra, G., Zaimovic, A., Mascetti, G. G., Gardini, S., Zambelli, U., Timpano, M., et al. (2001). Neuroendocrine responses to experimentally-induced psychological stress in healthy humans. *Psychoneuroendocrinology, 26*, 91–107.

Gillihan, S. J., & Farah, M. J. (2005). Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin, 131*, 76–97.

Gluck, M. A., & Myers, C. E. (2001). *An introduction to neural network modeling of the hippocampus and learning*. Cambridge: MIT Press.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review, 102*, 4–27.

Gruenewald, T. L., Kemeny, M. E., Aziz, N., & Fahey, J. L. (2004). Acute threat to the social self: Shame, social self-esteem, and cortisol activity. *Psychosomatic Medicine, 66*, 915–924.

Herman, J., Ostrander, M., Mueller, N., & Figueiredo, H. (2005). Limbic system mechanisms of stress regulation: Hypothalamo–pituitary–adrenocortical axis. *Progression in Neuropsychopharmacology and Biological Psychiatry, 29*, 1201–1213.

Johnson, M. K. (1988). Reality monitoring: An experimental phenomenological approach. *Journal of Experimental Psychology: General, 117*, 390–394.

Kazén, M., Baumann, N., & Kuhl, J. (2003). Self-infiltration vs. self-compatibility checking in dealing with unattractive tasks and unpleasant items: The moderating influence of state vs. action-orientation. *Motivation & Emotion, 27*, 157–197.

Keenan, J. P., Nelson, A., O'Connor, M., & Pascual-Leone, A. (2001). Self-recognition and the right hemisphere. *Nature, 409*, 305.

Kirschbaum, C., Kudielka, B. M., Gaab, J., Schommer, N. C., & Hellhammer, D. H. (1999). Impact of gender, menstrual cycle phase, and oral contraceptives on the activity of the hypothalamic–pituitary–adrenal axis. *Psychosomatic Medicine, 61*, 154–162.

Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. H. (1993). The "trier social stress test": A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*, 76–81.

Kirschbaum, C., Wolf, O. T., May, M., Wippich, W., & Hellhammer, D. H. (1996). Stress- and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. *Life Sciences, 58*, 1475–1483.

Koole, S. L., & DeHart, T. (2007). Self-affection without self-reflection: Origins, models, and consequences of implicit self-esteem. In C. Sedikides & S. Spencer (Eds.), *The self in social psychology* (pp. 36–86). New York: Psychology Press.

Krohne, H. W., Egloff, B., Kohlmann, C.-W., & Tausch, A. (1996). Untersuchungen mit einer deutschen version der positive and negative affect schedule (PANAS). *Diagnostica, 42*, 139–156.

Kuhl, J. (1992). A theory of self-regulation: Action versus state orientation, self-discrimination, and some applications. *Applied Psychology: An International Review, 41*, 97–129.

Kuhl, J. (2000). A functional-design approach to motivation and self-regulation: The dynamics of personality systems and interactions. In M. Boekaerts & P. R. Pintrich (Eds.), *Handbook of self-regulation* (pp. 111–169). San Diego, CA, US: Academic Press.

Kuhl, J. (2001). *Motivation und Persönlichkeit. Interaktionen psychischer Systeme [Motivation and personality: Interactions of mental systems]*. Göttingen: Hogrefe.

Kuhl, J., & Beckmann, J. (1994). *Volition and personality: State versus action orientation*. Göttingen: Hogrefe & Huber.

Kuhl, J., & Kazén, M. (1994). Self-discrimination and memory: State orientation and false self-ascription of assigned activities. *Journal of Personality & Social Psychology, 66*, 1103–1115.

Lepage, M., Habib, R., & Tulving, E. (1998). Hippocampal PET activations of memory encoding and retrieval: The HIPER model. *Hippocampus, 8*, 313–322.

Lovallo, W. R., & Thomas, T. L. (2000). Stress hormones in psychophysiological research: Emotional, behavioral, and cognitive implications. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 342–367). Cambridge University Press.

Mason, J. W. (1968). A review of psychoendocrine research on the pituitary–adrenal cortical system. *Psychosomatic Medicine, 30*, 576–607.

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. In S. M. McCann & J. M. Lipton (Eds.), *Annals of the New York academy of sciences. Neuroimmunomodulation: Molecular aspects, integrative systems, and clinical advances* (Vol. 840, pp. 33–44). New York Academy of Sciences.

McEwen, B. S., & Sapolsky, R. M. (1995). Stress and cognitive function. *Current Opinion in Neurobiology, 5*, 205–216.

Meng, X.-L., Rosenthal, R., & Rubin, D. B. (1992). Comparing correlated correlation coefficients. *Psychological Bulletin, 111*, 172–175.

Miller, G. E., Cohen, S., Rabin, B. S., Skoner, D. P., & Doyle, W. J. (1999). Personality and tonic cardiovascular, neuroendocrine, and immune parameters. *Brain, Behavior & Immunity, 13*, 109–123.

Moretti, M. M., & Higgins, E. T. (1999). Own versus other standpoints in self-regulation: Developmental antecedents and functional consequences. *Review of General Psychology, 3*, 88–223.

Platek, S. M., Keenan, J. P., Gallup, G. G. J., & Mohamed, F. B. (2004). Where am I? The neurological correlates of self and other. *Cognitive Brain Research, 19*, 114–122.

Pressman, S. D., & Cohen, S. (2005). Does positive affect influence health? *Psychological Bulletin, 131*, 925–971.

Pruessner, J. C., Baldwin, M. W., Dedovic, K., Renwick, R., Mahani, N. K., Meaney, M., et al. (2005). Self-esteem, locus of control, hippocampal volume, and cortisol regulation in young and old adulthood. *Neuroimage, 28*, 815–826.

Pruessner, J. C., Gaab, J., Hellhammer, D. H., Lintz, D., Schommer, N., & Kirschbaum, C. (1997). Increasing correlations between personality traits and cortisol stress responses obtained by data aggregation. *Psychoneuroendocrinology, 22*, 615–625.

Pruessner, J. C., Hellhammer, D. H., & Kirschbaum, C. (1999). Burnout, perceived stress, and cortisol responses to awakening. *Psychosomatic Medicine, 61*, 197–204.

Pruessner, J. C., Lord, C., Meaney, M., & Lupien, S. (2004). Effects of self-esteem on age-related changes in cognition and the regulation of the hypothalamic–pituitary–adrenal axis. *Annals of the New York Academy of Sciences, 1032*, 186–190.

Quirin, M., & Kuhl, J. (2006). Die Theorie der Persönlichkeits-System-Interaktionen [The theory of personality systems interactions (PSI)]. In V. Brandstätter-Morawietz & J. H. Otto (Eds.), *To appear in Handbuch der Allgemeinen Psychologie: Motivation und Emotion*. Göttingen: Hogrefe.

Quirin, M., Pruessner, J. C., & Kuhl, J. (2008). Adult attachment and HPA system regulation: Individual differences in reactive and awakening cortisol. *Psychoneuroendocrinology, 33*, 581–590.

Roy, A. (1996). HPA axis function and temperament in depression: A negative report. *Biological Psychiatry, 39*, 364–366.

Schommer, N. C., Kudielka, B. M., Hellhammer, D. H., & Kirschbaum, C. (1999). No evidence for a close relationship between personality traits and circadian cortisol rhythm or a single cortisol stress response. *Psychological Reports, 84*, 840–842.

Sheldon, K. M., Williams, G., & Joiner, T. (2003). *Self-determination theory in the clinic: Motivating physical and mental health*. Yale: University Press.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality & Social Psychology, 54*, 1063–1070.

Wolf, O. T., Witt, J., & Hellhammer, D. H. (2004). Autobiographic memory impairment following acute cortisol administration. *Psychoneuroendocrinology, 29*, 1093–1096.