

RESEARCH ARTICLE

Working with a sleep-deprived or a cognitively enhanced team member compromises motivation to contribute to group performance

Sebastian Sattler^{1,2,3}  | Jan A. Häusser⁴  | Nadira S. Faber^{5,6} 

¹Faculty of Sociology, Bielefeld University, Bielefeld, Germany

²Institute for Sociology and Social Psychology, University of Cologne, Cologne, Germany

³Pragmatic Health Ethics Research Unit, Montreal, Canada

⁴Department of Psychology and Sport Science, Justus-Liebig-University Giessen, Giessen, Germany

⁵Department of Psychology, University of Bremen, Bremen, Germany

⁶Oxford Uehiro Centre for Practical Ethics, University of Oxford, Oxford, UK

Correspondence

Sebastian Sattler, Faculty of Sociology, Bielefeld University, Universitätsstraße 25, Bielefeld, 33615, Germany.

Email: sebastian.sattler@uni-bielefeld.de

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Abstract

How does knowing another team member is cognitively impaired or enhanced affect people's motivation to contribute to the team's performance? Building on the Effects of Grouping on Impairments and Enhancements (GIE) framework, we conducted two between-subjects experiments ($N_{total} = 2,352$) with participants from a representative, nationwide sample of the working population in Germany. We found that another group member's impairment (sleep deprivation) and enhancement (taking enhancement drugs) lowered participants' intentions to contribute to the team's performance. These effects were mediated by lowered perceived competence (enhancement and impairment) and warmth (only enhancement) of the other group member. The reason for being impaired or enhanced (altruistic vs. egoistic reason) moderated the indirect effect of the impairment on intended effort via warmth. Our results illustrate that people's work motivation is influenced by the psychophysiological states of other group members. Hence, the enhancement of one group member can have the paradoxical effect of impairing the performance of another.

KEYWORDS

cognitive enhancement, drug misuse, group performance, impairment, sleep deprivation

1 | INTRODUCTION

The nature of work is in flux. Work is increasingly reliant on cognitive, rather than manual, labour while the pressure to work more efficiently is growing (Autor, 2014; Fink, 2016). Moreover, working long hours and in shifts is highly prevalent (McMenamin, 2007). As a consequence, both *impaired* cognitive functioning due to sleep deprivation (CDC, 2022; Chattu et al., 2018) and attempts to achieve *enhanced* cognitive functioning via substance intake are prevalent (Maier et al., 2018; Marschall et al., 2015). While the effects of psychophysiological impairments and enhancements on individual performance are well documented, their effects on performance in the social context, and

with that in groups and teams, remain elusive (Faber et al., 2017; Faulmüller et al., 2013; Racine et al., 2021). Building on the Effects of Grouping on Impairments and Enhancements (GIE) framework (Faber et al., 2017), we argue that one individual's cognitive impairment or enhancement is likely to reduce the performance of other group members by eroding their motivation to contribute to the team's performance. Hence, individual cognitive impairment or enhancement should produce effects above and beyond what could be expected for individual-level performance in a group performance context, due to decreases in motivation among other group members. In particular, we explore whether and under which conditions team members' cognitive impairment or enhancement affects how they are perceived by

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participants in regard to their competence and warmth—two key factors in interpersonal judgement (Fiske et al., 2002)—and how this, in turn, affects participants' motivation to contribute to group performance.

1.1 | The prevalence of group work

Many people often experience working in groups and not alone. Mirroring that, it is an often-repeated claim that group work is highly prevalent in modern work environments (e.g., Banks et al., 2019; Larson Jr., 2010). However, this claim has not yet been supported by representative empirical data. Therefore, we conducted a survey on the prevalence of group work within a representative sample of the German population with almost 18,000 respondents (see Methods and Results). Indeed, 30.3% of respondents indicated involvement in daily teamwork, and another 25.9% said they work in teams several times a week. Hence, the majority of the investigated working population works in groups at least several times a week.

1.2 | The GIE framework

Early accounts of group performance (Hackman & Morris, 1975; Steiner, 1972) already emphasized that the performance of groups is not a simple function of the performance of the individual group members, but rather a group's performance can amount to more or less than the sum of the capabilities of its members (see also Baumeister et al., 2016; Kerr & Tindale, 2004 for reviews). A key determinant of performance at the group-level is the individual group members' *motivation* to contribute to the group task (Hackman & Morris, 1975). A good proxy of group member motivation is how much effort they intend to expend on the mutual task. This intended effort is also a result of person perception processes: group members evaluate others (e.g., their estimated ability), and depending on this evaluation, they either invest more (e.g., Bond & Titus, 1983) or less (e.g., Karau & Williams, 1993) effort.

This perspective on group performance has been adopted by the Effects of Grouping on Impairments and Enhancements (GIE) framework, put forward by Faber et al. (2017). The GIE framework is a theoretical approach explaining how cognitive impairment or enhancement of individual group members can affect group performance beyond altering the individual capabilities and contributions of the impaired/enhanced group member. The GIE framework argues that individual-level impairment and enhancement actually become an inter-individual factor in group performance contexts, because group members monitor each other's capabilities and contributions and adapt their own effort to contribute to group performance. For example, group members might reduce their effort when they perceive another group member's contributions to be reduced due to cognitive impairment (e.g., sleep deprivation). Such a reduction in effort could be due to processes well-established in the 'social loafing' literature built on the seminal work by Ringelmann (1913), for example, group

members matching the effort they put in to that of the other group members (Jackson & Harkins, 1985), often in order to not feel exploited (Kerr, 1983; Kerr & Tindale, 2004). On the other hand, group membership could also compensate for the effects of impairments, as shown by Frings (2011), who found that the performance of individuals was more affected by fatigue than the performance of groups, arguably due to group monitoring processes being activated (also see Frings et al., 2008). Therefore, perception of other group members' capabilities and contributions is a crucial aspect of motivation to contribute to group performance, and these perceived capabilities and contributions are influenced by both cognitive impairment and enhancement.

Building on the reasoning of the GIE framework, we argue that there is an inter-individual *indirect* effect of impairment and enhancement on motivation to contribute in group settings that operates via person perception (Faber et al., 2017; Faulmüller et al., 2013). More precisely, impairment (e.g., due to sleep deprivation) or enhancement (e.g., due to consuming enhancement drugs) of one group member should affect how this group member is perceived, and thereby the intended effort of the other group members to contribute to group work.

1.3 | Individual-level impairment in group settings

Cognitive impairments in-group members can result from many different adverse contextual factors. One highly prevalent contextual factor associated with considerable cognitive impairment is insufficient sleep, which has been declared a 'public health epidemic' (CDC, 2018). Lack of sleep is not only associated with lower cognitive performance (Harrison & Horne, 2000; Lim & Dinges, 2010), but also with reduced productivity at the individual level (e.g., Pilcher & Morris, 2020).

Although the effects on sleep deprivation in the social domain have gained prominence over the last few years (Gordon et al., 2017; Sundelin & Holding, 2019), the effects of sleep deprivation on group-related performance remain understudied. Only two studies have examined the effects of sleep deprivation on group performance (Baranski et al., 2007; Hoeksema-van Orden et al., 1998). However, both studies used very small samples, and all group members were sleep deprived to the same degree. Both studies reported that group members attempted to counteract their impairments—at least under certain conditions. Similarly, individuals are more inclined to make use of (even mediocre) advice from others when performing a task while sleep-deprived (Häusser et al., 2016). Moreover, in dyadic group performance tasks with sleep-deprivation-heterogeneous dyads (one individual sleep deprived, one well-rested) only small performance decrements were found, with no performance loss in some tasks, and even positive effects of sleep deprivation occurred (Holding et al., 2019). However, it is unclear whether unimpaired people would actively compensate for impairment they see in other group members (Faber et al., 2017; Frings, 2011), and, if so, which processes would explain this relationship.

In Study 1, we assess how people perceive another group member who is impaired due to sleep deprivation (compared to a non-impaired group member), regarding two established dimensions people use to

make sense of others: warmth and competence (Fiske et al., 2002). Warmth (with its sub-dimensions of trustworthiness and sociability) and competence (with its sub-dimensions of capability and agency) have been shown to be crucial in several social interactions in the work context and beyond (Fiske, 2018). We argue that group members impaired due to sleep deprivation are seen as less competent than group members without this impairment. Hence, they expect weaker performance from sleep-deprived group members (Sundelin & Holding, 2019). Sleep-deprived group members may also be seen as less warm because attending work in such a state can increase the burden on other team members, and thus be seen as uncooperative. Furthermore, sleep deprivation triggers social withdrawal, which is perceived and responded to by others, for example, by increasing social distance or a reduced desire to socially interact with (Ben Simon & Walker, 2018).

We further investigate how person perceptions translate into participants' intention to contribute to joint performance when encountering a group member who is impaired due to being sleep-deprived (compared to not impaired this way). We argue that the lower the competence and warmth attributed to a group member who is impaired due to sleep deprivation, the lower the motivation to contribute to teamwork. In other words, insufficient sleep of one group member should not only reduce their own contributions but also reduce the contributions of fellow group members, thereby further jeopardizing group performance beyond individual impairments.

As there is insufficient research on when and why sleep deprivation affects perceptions by others (Sundelin & Holding, 2019), we examine whether perceptions of a group member who is impaired due to sleep deprivation depend on the reason for this group member's sleep deprivation. For example, sleep deprivation may be due to altruistic reasons (e.g., care responsibilities) or egoistic reasons (e.g., partying through the night). If sleep deprivation is due to egoistic reasons, this can be a signal of congruence between the mental state and the character of the person driving the selfish behaviour, which could exacerbate the negative effect of sleep deprivation on warmth perceptions. However, altruistic reasons could be seen as more acceptable and justified due to signalling prosocial motivation. With respect to perception of competence, we argue that an impairment in the form of sleep deprivation due to egoistic reasons might be perceived as being voluntary, as compared to altruistic reasons that are perceived as more imperative. Hence, accepting an impaired state voluntarily may be seen as a bad judgement in resource allocation and therefore as less competent.

Therefore, we investigate how the reason for sleep deprivation affects competence and warmth perceptions and the intended effort to contribute to group performance. We argue that the negative indirect effect of impairment due to sleep deprivation on intended effort via reduced competence and warmth is likely to be buffered by having an altruistic, rather than egoistic, reason for such an impairment.

We postulate the following hypotheses (see Figure 1):

H_1 : People perceive a group member who is impaired due to sleep deprivation (vs. being non-impaired) as less *competent*, and this reduces their intended effort to contribute to group performance.

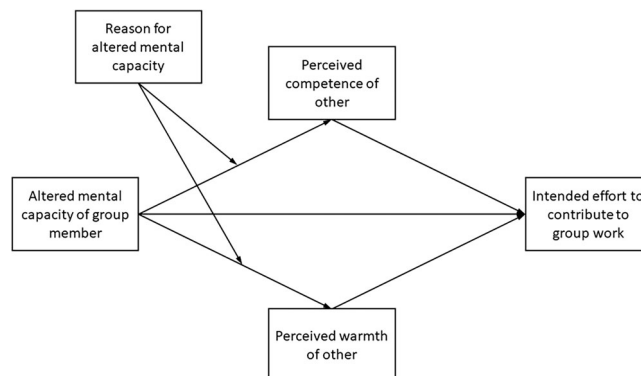


FIGURE 1 Overview of the explored relations. Altered mental capacity of group member can be either impairment due to sleep deprivation (Study 1) or enhancement due to prescription stimulant drug intake (Study 2). Reason for altered mental capacity is either altruistic or egoistic.

H_2 : People perceive a group member who is impaired due to sleep deprivation (vs. being non-impaired) as less *warm*, and this reduces their intended effort to contribute to group performance.

H_3 : An egoistic reason (as compared to an altruistic reason) for the team member's impairment due to sleep deprivation strengthens the negative indirect effect of this impairment on intended effort via perceived *competence*.

H_4 : An egoistic reason (as compared to an altruistic reason) for the team member's impairment due to sleep deprivation strengthens the negative indirect effect of this impairment on intended effort via perceived *warmth*.

1.4 | Individual-level enhancement in group settings

To cope with work demands, some people attempt to increase their productivity through cognitive enhancement (Baum et al., 2021). They take drugs like methylphenidate (brand name Ritalin®) or modafinil (Provigil®), which were originally developed to treat neuropsychological diseases, such as attention deficit hyperactivity disorder (ADHD) or narcolepsy. It has been shown that these pharmaceuticals can also improve cognitive abilities (i.e., memory, attention) in healthy individuals (Battleday & Brem, 2015; Roberts et al., 2020). For many, these substances are readily available via friends, family, by feigning symptoms at a doctor's office or via the black market (Faraone et al., 2020; van Veen et al., 2022). One study found that one in five people in the United States aged 16 to 65 reported taking enhancement drugs in the past year (Maier et al., 2018). Investigating how such enhancement substances play out in the social context has been emphasized as necessary (e.g., Faulmüller et al., 2013; Racine et al., 2021; Veit et al., 2020), and first empirical investigations confirm that need, for example, by showing that methylphenidate can influence prosocial behaviour, specifically the willingness to help other people in risky situations

(Gross et al., 2021). While hypotheses have been derived from the GIE framework (Faber et al., 2017), there is not yet any data on how the consumption of enhancement substances affects person perception and performance in the group context.

In Study 2, we assess how a person who is cognitively enhanced due to drug intake (compared to a non-enhanced person) is perceived. Analogous to Study 1, we investigate the person's perceptions of warmth and competence (Fiske et al., 2002), which have been recently discussed in the context of cognitive enhancement (Grewal et al., 2020). We argue that being cognitively enhanced reduces both competence and warmth attributed to the enhanced group member. While one might argue that competence attributions of an enhanced individual could increase because people believe in the effectiveness of these pharmaceuticals, at the same time, people generally have negative sentiments towards users of enhancement drugs (Sattler, S. (2016), Dubljevic, V., Racine, E. (2023), Huber, S., Sattler, S., Mehlkop, G. (2023), Schelle et al., 2014). For example, they judge achievements under the influence of cognitive enhancement as undeserved and unpraiseworthy (Faber et al., 2015; Santoni de Sio et al., 2016). Furthermore, engaging in a behaviour that might be seen as reckless (i.e., risking side effects) and illegal may further fuel negative sentiments towards drug-enhanced team members and increase the likelihood that they will be viewed as incompetent. The act of taking enhancement drugs could also suggest that the person requires enhancement drugs to be able to work. Hence, we argue that enhanced group members are perceived as less competent than non-enhanced group members. Moreover, an enhanced group member might be seen as less warm than a group member who did not take enhancement drugs, as taking such substances can be seen as an unfair attempt to outperform others (Faber et al., 2016). This could even potentially lead to mechanistic dehumanization of enhancement users (Faulmüller et al., 2013; Grewal et al., 2020) with dehumanization having been shown to be linked to lower warmth perceptions (Harris & Fiske, 2011).

In Study 2, we assess how such perceptions of an enhanced group member affect participants' intentions to put effort into joint performance. We suggest that both reduced competence and warmth attributed to an enhanced group member reduce this effort.

Analogous to Study 1, we varied the reason for enhancement drug use (egoistic vs. altruistic) to explore whether the reason for cognitive enhancement affects person perception and performance motivation. We argue that having an altruistic reason (vs. an egoistic reason) for being enhanced buffers the negative effects of enhancement on competence and warmth attributions, which in turn affect the intended effort to contribute to performance in a group.

We postulate the following hypotheses (see Figure 1):

H₅: People perceive a group member who is cognitively enhanced due to drug intake (vs. not enhanced) as less *competent*, and this reduces their intended effort to contribute to group performance.

H₆: People perceive a group member who is cognitively enhanced due to drug intake (vs. not enhanced) as less *warm*, and this reduces their intended effort to contribute to group performance.

H₇: An egoistic reason (as compared to an altruistic reason) for the group member's cognitive enhancement due to drug intake strength-

ens the negative indirect effect of this enhancement on intended effort via perceived *competence*.

H₈: An egoistic reason (as compared to an altruistic reason) for the group member's cognitive enhancement due to drug intake strengthens the negative indirect effect of this enhancement on intended effort via perceived *warmth*.

2 | METHODS

Because the methods and the analyses of Study 1 and Study 2 are very similar, we will first describe the methods of both studies and then present their results (rather than organizing the presentation of methods and results study-wise). Before doing so, we will briefly present a survey on the prevalence of group work that was part of the full representative panel sample in which context the current studies were conducted.

2.1 | Prevalence of group work

Frequency of group work was assessed in the full representative panel sample of the working population (i.e., respondents in Studies 1 and 2 and respondents not assigned to any of the experiments in the two studies; $N = 17,761$) with the question: 'In the last 12 months, about how often did it occur that you worked with others in a team to complete your work?' with response options 'daily' [1], 'several times per week' [2], 'once per week' [3], 'several times per month' [4], 'once per month' [5], 'less than once per month' [6], and 'never' [7].

2.2 | Study 1

2.2.1 | Design and participants

Study 1 used a web-based vignette experiment with a 2 (impairment due to sleep deprivation of group member: yes vs. no) $\times$ 2 (reason: egoistic vs. altruistic) between-subjects design (Figure S1).

Our experiment was part of a larger study aiming for greater heterogeneity and a more representative set of participants compared to common student or crowdsourced samples. Thus, participants were part of a nationwide sample of German-speaking residents in Germany aged 18 or older. To recruit participants, we employed forsa.omninet, which provides a panel of the German population that is representative regarding sex, age, education and federal state. Participants were approached using a multi-stage, random process. This sampling frame was based on a sample in which every household in Germany has the same statistical chance to participate. This sampling frame also captures infrequent Internet users and prevents self-selection into the panel or respondents with multiple accounts. The gross sample included 47,406 adults in and outside the working population; of which 27,149 (57.3%) consented to participate, and 24,809 (91.4%)

TABLE 1 Pairwise correlations and descriptive statistics of Study 1 ($N = 1,181$) and 2 ($N = 1,171$).

Study 1	Pairwise correlations				Descriptive statistics	
	1.	2.	3.	4.	Mean (SD)	Min-Max
1. Impairment	–				–	0–1
2. Reason	0.001	–			–	0–1
3. Competence	–0.324***	–0.269***	–		4.520 (1.860)	0–8
4. Warmth	–0.010	–0.608***	0.540***	–	4.930 (2.116)	0–8
5. Intended effort	–0.087**	–0.176***	0.434***	0.391***	6.067 (1.747)	0–8
Study 2	1.	2.	3.	4.	Mean (SD)	Min-Max
1. Enhancement	–				–	0–1
2. Reason	0.015	–			–	0–1
3. Competence	–0.264***	–0.243***	–		4.564 (1.876)	0–8
4. Warmth	–0.213***	–0.540***	0.643***	–	4.492 (2.118)	0–8
5. Intended effort	–0.112***	–0.162***	0.451***	0.414***	6.001 (1.723)	0–8

Abbreviations: SD, Standard deviation; Min, Minimum; Max, Maximum.

* $p < .05$, ** $p < .01$, *** $p < .001$.

completed the study. Study 1 was assigned to a subsample of 1,467 respondents who were part of the working population. 1,181 participants completed the experiment (49.79% females; mean age: 48.47; $SD = 12.374$; mixed educational background). This sample size is sufficient to detect small effects ($f^2 < .012$ for the focal mediation effects (H1 and H2) with $\alpha = .05$ and a power of .9; Faul et al., 2007). Participants provided informed consent and were financially compensated for their participation.

2.2.2 | Materials and procedure

We randomly assigned each respondent to one short description of a hypothetical workplace situation. In this vignette, respondents were asked to think about a team task in a company that offers performance-based pay. In the impairment conditions ($N = 736$), another group member was described as being overtired due to working late in another job. In the non-impairment conditions ($N = 731$), no information regarding the sleep status of the group member was provided. To manipulate the reason for the impairment, the motivation was framed as either altruistic (i.e., needing additional income to support a relative) or as egoistic (i.e., interested in buying luxury goods). The reason for working late in another job (altruistic versus egoistic motive) was also provided in the unimpaired conditions. The numbers of respondents in the four experimental conditions were as follows: impairment/altruistic: 363, impairment/egoistic: 373, non-impairment/altruistic: 369 and non-impairment/egoistic: 362.

After reading the scenarios, participants gave their impressions of the group member regarding perceived warmth and competence (Fiske et al., 2002; Gaucher et al., 2018). Warmth and competence were conceptualized as mediators and were assessed in a random order with a single-item measure on a 9-point scale ranging from 'not at all' [0] to

'extremely' [8]; plus the option 'no response' (see Figure S1 for wording and Table 1 for descriptive statistics).

Then, participants indicated their intended effort for the team task. Intended effort was assessed on a 9-point scale ran from 'none' [0] to 'maximum' [8]; plus the option 'no response'.

2.2.3 | Pretesting

To evaluate and improve the instructions and instruments, the survey materials underwent pretesting ($N = 5$) using the think-aloud technique and probing questions (Van Someren et al., 1994) and a further pretest under naturalistic conditions ($N = 34$). The results of these pretests demonstrated the materials were clear, understandable and suitable for the nationwide sample.

2.3 | Study 2

2.3.1 | Design and participants

Analogous to Study 1, Study 2 used a web-based vignette experiment with a 2 (enhancement drug use of group member: yes vs. no) $\times$ 2 (reason: egoistic vs. altruistic) between-subjects design (Figure S1).

Participants were recruited using the same process as in Study 1. There was no participant overlap between the studies. 1,465 participants were assigned to Study 2. After deleting missing values due to drop-out or choosing 'no response', 1,171 participants comprised the analytical sample (49.19% females; mean age: 48.61; $SD = 12.31$, mixed educational background). This sample size is sufficient to detect small effects ($f^2 < .012$ for the focal mediation effects (H5 and H6) with $\alpha = .05$ and a power of .9; Faul et al., 2007). Participants

provided informed consent and were financially compensated for their participation.

2.3.2 | Materials and procedure

Each respondent was randomly assigned to one short description of a hypothetical workplace situation in which respondents should think about a team task in a company that offers performance-based pay. In the enhancement conditions ($N = 594$), another group member was described as taking enhancement drugs to increase performance beyond their normal level. In the non-enhancement conditions ($N = 577$), no information regarding drug use was provided. The reason for high work ambition use was either framed as altruistic (i.e., needing additional income to support a relative) or as egoistic (i.e., interested in buying luxury goods). This information on altruistic versus egoistic motives for high work ambition was also provided in the non-enhancement conditions. The number of respondents in the four experimental conditions were as follows: enhancement/altruistic: 299, enhancement/egoistic: 295, non-enhancement/altruistic: 299 and non-enhancement/egoistic: 278.

After reading the scenarios, the group member was evaluated on perceived warmth and competence, the same mediating variables as in Study 1 (see Figure S1 for exact wording and Table 1 for descriptive statistics).

Then, participants indicated their intended effort for the team task as in Study 1.

2.3.3 | Pretesting

Similar to Study 1, we conducted a pretest with think aloud and probing questions ($N = 5$) as well as a pretest under naturalistic conditions ($N = 39$) that showed the materials were suitable for the nationwide sample.

3 | RESULTS

The data reported in this article will be openly available via the institutional repository of Bielefeld University (Sattler et al., 2023), and the analysis code is available upon request.

3.1 | Prevalence of group work

We found that every third respondent of the of the inquired working population ($N = 17,761$) engaged in group work on a daily basis (30.2%). Another quarter (25.9%) engaged in group work several times a week, 6.2% once a week, 11.2% several times a month and 4.8% once a month. About every tenth respondent worked in groups less frequently than monthly (11.7%), a similar proportion reported never working in groups (10.7%). Hence, the majority worked in groups at least several times a week.

3.2 | Study 1

First, we tested whether the experimental manipulation of group member impairment through sleep deprivation had the predicted negative effect on intended effort. A t -test showed statistically significant lower intended effort when the other group member was impaired ($M = 5.92$, $SD = 1.795$, $N = 621$) as compared to when the other group member was unimpaired ($M = 6.23$, $SD = 1.679$, $N = 560$), $t = 2.997$, $p = .003$, Cohen's $d = .175$ with a 95% CI = 0.060;0.289, see also Table 1 for descriptive statistics).

A mediation analysis with Model 4 of the SPSS macro PROCESS (Hayes, 2017) tested if perceived competence and warmth mediate the effect of group member impairment on intended effort. To increase the accuracy of the indirect effects, we used percentile bootstrapping (with $N = 10,000$ bootstrap samples) and 95% confidence intervals (CI) (Hayes, 2017; MacKinnon et al., 2004). We used heteroscedasticity consistent standard errors (HC3) (Hayes & Cai, 2007). Our results show that impairment decreases perceived competence ($B = -1.205$, $p < .001$, 95% CI = -1.406 ; -1.004), but not warmth ($B = -0.042$, $p = .733$, 95% CI = -0.283 ; 0.199 , see Table 2 and Figure 2).

The model further shows that the mediators, competence ($B = 0.304$, $p < .001$, 95% CI = 0.231 ; 0.377) and warmth ($B = 0.179$, $p < .001$, 95% CI = 0.199 ; 0.238), were positively associated with the level of effort. When controlling for the mediators, impairment has no remaining direct effect on effort ($B = 0.070$, $p = .468$, 95% CI = -0.119 ; 0.259). Hence, competence serves as a mediator between impairment and effort (indirect effect = -0.366 , 95% CI_{boot} = -0.479 ; -0.265 , supporting H_1), but warmth does not (indirect effect = -0.008 , 95% CI_{boot} = -0.053 ; 0.036 , not supporting H_2).

We ran PROCESS Model 7 to test for moderated mediation processes, namely whether the reason for the impairment moderated the effects of impairment on the mediators, competence and warmth. Hence, we tested two first-stage moderated mediations.¹

In the mediator variable model with competence attributions as the outcome variable (Table 3), no significant interaction was found between impairment and reason ($B = -0.090$, $p = .648$, 95% CI = -0.477 ; 0.297) (see Figure 3). An examination of the conditional indirect effects of impairment via competence on intended effort revealed negative indirect effects of impairment due to an altruistic (indirect effect = -0.353 , 95% CI_{boot} = -0.475 ; -0.244) or egoistic reason (indirect effect = -0.380 , 95% CI_{boot} = -0.512 ; -0.265). However, the conditional indirect effects of impairment due to altruistic or egoistic reasons did not statistically significantly differ from each other (the confidence interval for the index of moderated mediation included zero, 95% CI_{boot} = -0.147 ; 0.090). Hence, this mediation via competence was not moderated by reason (not supporting H_3).

In contrast, we found that the effect of impairment on warmth attributions depends on reason for the impairment (as indicated by the interaction effect in Table 3, $B = -0.659$, $p = .001$, 95% CI = -1.043 ; -0.274) in the model with warmth as the outcome

¹ To examine the stability of the results, we ran additional models in which we included sex, age and the frequency of working in groups. These additional models did not lead to different conclusions.

TABLE 2 Mediation models.

	Study 1 (N = 1,181)			
	Effect	SE	t	95% CI
Mediator variable model with competence as outcome ($R^2 = 0.105$, $F_{HC3} = 138.397^{***}$)				
Constant	5.154 ^{***}	0.073	71.034	[5.011; 5.296]
Impairment (vs. control)	−1.205 ^{***}	0.102	−11.764	[−1.406; −1.004]
Mediator variable model with warmth as outcome ($R^2 = 0.000$, $F_{HC3} = 0.117$)				
Constant	4.952 ^{***}	0.085	58.490	[4.786; 5.118]
Impairment (vs. control)	−0.042	0.123	−0.342	[−0.283; 0.199]
Dependent variable model with intended effort as outcome ($R^2 = 0.224$, $F_{HC3} = 82.499^{***}$)				
Constant	3.775 ^{***}	0.187	20.212	[3.408; 4.141]
Impairment (vs. control)	0.070	0.096	0.727	[−0.119; 0.259]
Competence	0.304 ^{***}	0.037	8.184	[0.231; 0.377]
Warmth	0.179 ^{***}	0.030	5.879	[0.199; 0.238]
	Effect	SE (Boot)		95% CI (Boot)
Indirect effect of competence	−0.367	0.054		[−0.479; −0.265]
Indirect effect of warmth	−0.008	0.022		[−0.053; 0.036]
Total indirect effect	−0.374	0.064		[−0.504; −0.253]
	Study 2 (N = 1,171)			
	Effect	SE	t	95% CI
Mediator variable model with competence as outcome ($R^2 = 0.069$, $F_{HC3} = 87.088^{***}$)				
Constant	5.066 ^{***}	0.075	67.199	[4.918; 5.214]
Enhancement (vs. control)	−0.988 ^{***}	0.106	−9.332	[−1.196; −0.781]
Mediator variable model with warmth as outcome ($R^2 = 0.045$, $F_{HC3} = 55.704^{***}$)				
Constant	4.950 ^{***}	0.081	61.013	[4.791; 5.109]
Enhancement (vs. control)	−0.903 ^{***}	0.121	−7.464	[−1.140; −0.665]
Dependent variable model with intended effort as outcome ($R^2 = 0.230$, $F_{HC3} = 92.203^{***}$)				
Constant	3.857 ^{***}	0.179	21.506	[3.505; 4.209]
Enhancement (vs. control)	0.060	0.094	0.635	[−0.125; 0.244]
Competence	0.293 ^{***}	0.035	8.397	[0.225; 0.362]
Warmth	0.173 ^{***}	0.030	5.806	[0.114; 0.231]
	Effect	SE (Boot)		95% CI (Boot)
Indirect effect of competence	−0.290	0.045		[−0.380; −0.207]
Indirect effect of warmth	−0.156	0.034		[−0.227; −0.094]
Total indirect effect	−0.446	0.053		[−0.551; −0.343]

Notes: CI = bootstrapped 95% confidence interval (with bootstrap sample size = 10,000); SE = Standard error.

* $p < .05$, ** $p < .01$, *** $p < .01$. Effects in bold indicate that the respective 95% CI (Boot) does not include zero and are thus considered statistically significant.

variable. Figure 3 shows that impairment due to altruistic reasons slightly increased warmth attributions compared to the unimpaired control, while impairment due to egoistic reasons slightly reduced warmth attributions. Thus, we found a moderated mediation of impairment via warmth on intended effort (the confidence interval

for the index of moderated mediation did not include zero, 95% $CI_{boot} = -0.205; -0.044$). Hence, an impairment due to an egoistic reason had a negative indirect effect on effort via warmth (*indirect effect* = -0.068 , 95% $CI_{boot} = -0.129; -0.015$), while an impairment due to an altruistic reason had a positive indirect effect on effort via

TABLE 3 Moderated mediation model for Study 1 ($N = 1,181$).

	Effect	SE	t	95% CI
Mediator variable model with competence as outcome ($R^2 = 0.177$, $F_{HC3} = 86.712^{***}$)				
Constant	5.610 ^{***}	0.094	59.547	[5.425; 5.794]
Impairment (vs. control)	-1.161 ^{***}	0.135	-8.610	[-1.425; -0.896]
Egoistic reason (vs. altruistic)	-0.953 ^{***}	0.140	-6.802	[-1.228; -0.678]
Impairment $\times$ Egoistic reason	-0.090	0.197	-0.457	[-0.477; 0.297]
Mediator variable model with warmth as outcome ($R^2 = 0.376$, $F_{HC3} = 233.338^{***}$)				
Constant	6.017 ^{***}	0.097	62.104	[5.827; 6.207]
Impairment (vs. control)	0.277 [*]	0.131	2.108	[0.019; 0.535]
Egoistic reason (vs. altruistic)	-2.226 ^{***}	0.141	-15.764	[-2.503; -1.949]
Impairment $\times$ Egoistic reason	-0.659 ^{***}	0.196	-3.361	[-1.043; -0.274]
Dependent variable model with intended effort as outcome ($R^2 = 0.224$, $F_{HC3} = 82.499^{***}$)				
Constant	3.775 ^{***}	0.187	20.212	[3.408; 4.141]
Impairment (vs. control)	0.070	0.096	0.727	[-0.119; 0.259]
Competence	0.304 ^{***}	0.037	8.184	[0.231; 0.377]
Warmth	0.179 ^{***}	0.030	5.879	[0.199; 0.238]
	Effect	SE (Boot)		95% CI (Boot)
Conditional indirect effects of competence				
For altruistic reason	-0.353	0.059		[-0.475; -0.244]
For egoistic reason	-0.380	0.064		[-0.512; -0.265]
Index of moderated mediation	-0.027	0.060		[-0.147; 0.090]
Conditional indirect effects of warmth				
For altruistic reason	0.050	0.025		[0.002; 0.102]
For egoistic reason	-0.068	0.029		[-0.129; -0.015]
Index of moderated mediation	-0.118	0.041		[-0.205; -0.044]

Notes: CI = bootstrapped 95% confidence interval (with bootstrap sample size = 10,000); SE = Standard error.

* $p < .05$, ** $p < .01$, *** $p < .001$. Effects in bold indicate that the respective 95% CI (Boot) does not include zero and are thus considered statistically significant.

warmth (*indirect effect* = 0.050, 95% CI_{boot} = 0.002;0.102). Thus, this pathway was moderated by reason for impairment (supporting H_4).

3.3 | Study 2

A t -test showed statistically that the intended effort of the respondent was significantly lower in the enhancement condition ($M = 5.81$, $SD = 1.735$, $N = 577$) compared to the non-enhancement condition ($M = 6.20$, $SD = 1.690$, $N = 594$, $t = 3.856$, $p < .001$, *Cohen's d* = .226 with a 95% $CI = 0.110$;0.340, see Table 1).

We used PROCESS Model 4 to examine the mediating role of competence and warmth in the relationship between enhancement and intended effort. We found that enhancement decreases competence ($B = -0.988$, $p < .001$, 95% $CI = -1.196$; -0.781) and also warmth ($B = -0.903$, $p < .001$, 95% $CI = -1.140$; -0.665, see Table 2 and Figure 2). In turn, competence ($B = 0.293$, $p < .001$, 95% $CI = 0.225$;0.362) and warmth ($B = 0.173$, $p < .001$, 95%

$CI = 0.114$;0.231) were positively associated with intended effort, whereby enhancement has no remaining direct effect on effort when controlling for both mediators ($B = 0.060$, $p = .525$, 95% $CI = -0.125$;0.244). We found negative indirect effects of enhancement via competence (*indirect effect* = -0.290, 95% $CI_{boot} = -0.380$; -0.207, supporting H_5) and warmth (*indirect effect* = -0.156, 95% $CI_{boot} = -0.227$; -0.094, supporting H_6) on intended effort.

Furthermore, PROCESS Model 7 (Table 4) shows that the negative effect of enhancement on competence and warmth is not moderated by reason for enhancement as indicated by the statistically insignificant interaction effect ($B = -0.024$, $p = .906$, 95% $CI = -0.428$;0.379) between enhancement and reason (see also Figure 3). While H_5 was supported because enhancement has indirect effects on intended effort via competence for both altruistic (*indirect effect* = -0.283, 95% $CI_{boot} = -0.395$; -0.183) and egoistic reasons (*indirect effect* = -0.290, 95% $CI_{boot} = -0.400$; -0.191), H_7 was not supported as no evidence was found for a moderated mediation (the

TABLE 4 Moderated mediation model for Study 2 ($N = 1,171$)

	Effect	SE	t	95% CI
Mediator variable model with competence as outcome ($R^2 = 0.127$, $F_{HC3} = 56.311^{***}$)				
Constant	5.492 ^{***}	0.103	53.585	[5.291; 5.693]
Enhancement (vs. control)	-0.963 ^{***}	0.145	-6.639	[-1.248; -0.679]
Egoistic reason (vs. altruistic)	-0.884 ^{***}	0.147	-6.033	[-1.171; -0.596]
Enhancement $\times$ Egoistic reason	-0.024	0.206	-0.119	[-0.428; 0.379]
Mediator variable model with warmth as outcome ($R^2 = 0.335$, $F_{HC3} = 201.642^{***}$)				
Constant	5.970 ^{***}	0.090	66.452	[5.794; 6.146]
Enhancement (vs. control)	-0.719 ^{***}	0.139	-5.181	[-0.991; -0.447]
Egoistic reason (vs. altruistic)	-2.117 ^{***}	0.137	-15.455	[-2.386; -1.849]
Enhancement $\times$ Egoistic reason	-0.306	0.203	-1.511	[-0.704; 0.091]
Dependent variable model with intended effort as outcome ($R^2 = 0.230$, $F_{HC3} = 92.203^{***}$)				
Constant	3.857 ^{***}	0.179	21.506	[3.505; 4.209]
Enhancement (vs. control)	0.060	0.094	0.635	[-0.125; 0.244]
Competence	0.293 ^{***}	0.035	8.397	[0.225; 0.362]
Warmth	0.173 ^{***}	0.030	5.806	[0.114; 0.231]
	Effect	SE (Boot)		95% CI (Boot)
Conditional indirect effects of competence				
For altruistic reason	-0.283	0.054		[-0.395; -0.183]
For egoistic reason	-0.290	0.054		[-0.400; -0.191]
Index of moderated mediation	-0.007	0.061		[-0.128; 0.115]
Conditional indirect effects of warmth				
For altruistic reason	-0.124	0.031		[-0.191; -0.069]
For egoistic reason	-0.177	0.041		[-0.263; -0.104]
Index of moderated mediation	-0.053	0.038		[-0.133; 0.016]

Notes: SE = Standard error; CI = confidence interval; Boot = bootstrapped with 10,000 bootstrap samples.

* $p < .05$, ** $p < .01$, *** $p < .001$. Effects in bold indicate that the respective 95% CI (Boot) does not include zero and are thus considered statistically significant.

confidence interval for the index of moderated mediation included zero, 95% $CI_{boot} = -0.128; 0.115$).

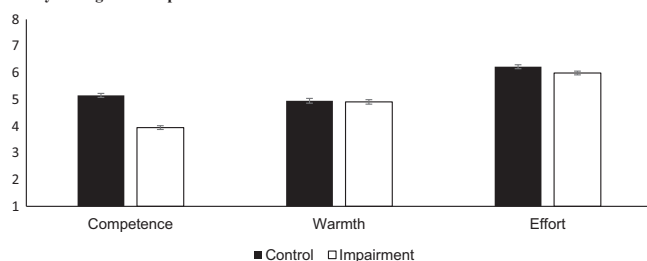
In the mediator variable model with warmth as the outcome variable, we found no evidence that the negative effect of enhancement on warmth was moderated by reason for enhancement ($B = -0.306$, $p = .131$, 95% $CI = -0.704; 0.091$) (Figure 3). Also, the negative conditional indirect effects of enhancement on intended effort via warmth for both, altruistic (*indirect effect* = -0.124, 95% $CI_{boot} = -0.191; -0.069$) and egoistic reasons (*indirect effect* = -0.177, 95% $CI_{boot} = -0.263; -0.104$) are statistically significant, supporting H_6 . However, against H_8 , these conditional indirect effects do not substantially differ from each other (the confidence interval for the index of moderated mediation included zero, 95% $CI_{boot} = -0.133; 0.016$).

4 | DISCUSSION

We examined how cognitive impairment and enhancement of one group member (due to sleep deprivation or enhancement drug intake)

affect the intended effort of other group members in contributing to joint performance. Using two vignette experiments from a representative, nationwide sample of the German working population, we found that both sleep deprivation and the use of enhancement drugs by another group member reduced participants' intended effort to contribute to a mutual task. These effects were mediated by reduced perceived competence of the impaired group member and both reduced perceived warmth and competence of the enhanced group member. In an exploratory manner, we further examined whether the reason for the impairment or enhancement (altruistic vs. egoistic) moderated the indirect effects of impairment and enhancement on intended effort, but found little evidence of moderation. In sum, our results illustrate that people's work motivation can be altered by the psychophysiological states of their fellow group members. One team member's sleep deprivation can decrease the performance of another, and one team member's pharmacologically-induced performance enhancement can—paradoxically—lead to performance impairment in another.

Study 1: Cognitive Impairment



Study 2: Cognitive Enhancement

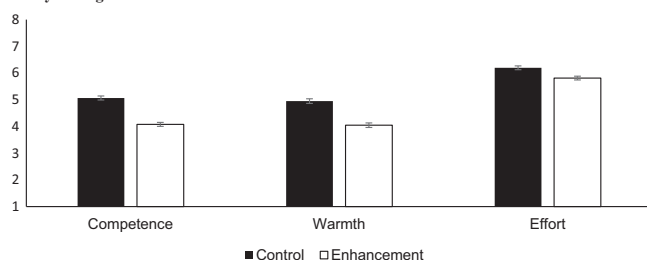


FIGURE 2 Effects of impairment (vs. control) on competence, warmth, and intended effort in Study 1 ($N = 1181$) and effects of enhancement (vs. control) on competence, warmth, and intended effort in Study 2 ($N = 1171$).

4.1 | Theoretical implications

Despite the high prevalence of sleep deprivation and the use of enhancement drugs in collaborative work settings, little is known about their *inter-individual* effects on performance. It is well established in group research that group performance is not merely the sum of individual group members' capabilities, but is—in addition—determined by the coordination within the group and mutual influences of the group members on individual motivation and individual capabilities (Hackman & Morris, 1975; Larson Jr., 2010). In the GIE framework, it has been argued that the effects of cognitive impairments and enhancements on individual performance might fundamentally differ from the effects that they have on group performance, by producing inter-individual effects in addition to the individual-level effects (Faber et al., 2017). It has been argued that interaction and interdependence within a group lead to 'social side effects' of individual-level impairments and enhancements, particularly regarding motivation losses of group members. Building on this theoretical framework, we provide first empirical evidence for such social side effects in group tasks.

As an extension of the GIE framework, our study delves deeper into the interpersonal perception process preceding motivational changes. We identify warmth and competence perceptions as underlying mechanisms for motivation losses. Thus, our study supports earlier accounts of negative perceptions by the general public towards users of enhancement drugs (Grewal et al., 2020; Schelle et al., 2014), and provides evidence that these perceptions can result in reduced motivation to contribute to a mutual task. Thus, even if the group potential (Hackman & Morris, 1975) is increased due to cognitive enhancement of one group member, at the same time, it may be reduced due to decreased performance of other group members. On the other hand,

when a team member suffers from sleep deprivation, inter-individual motivational decreases occur, which further reduce team performance (Ben Simon et al., 2020; Lim & Dinges, 2010).

In sum, our research helps to better understand the complex interplay of individual group members' capabilities and motivation with regard to group performance through the utilization of a person perception approach.

4.2 | Practical implications

The potential dangers of cognitive enhancement and impairment in work contexts have been discussed with respect to cognitive and motivational effects, health, and ethical considerations (e.g., Barnes, 2011; Barnes & Wagner, 2009; Bavelier et al., 2019; Maslen et al., 2014; Racine et al., 2021; Sattler, 2016; Wagner et al., 2012). Our findings reveal that beyond impairment or enhancement effects of individuals with sleep deprivation and enhancement drug use, such psychophysiological states are likely to have negative inter-individual effects on the effort exerted by other members of the group. Hence, from a group perspective, these inter-individual effects of enhancement and impairments can negatively affect group performance as a whole. This implies that working while being sleep deprived is even more problematic in group contexts, as compared to individual tasks, and that potential positive effects of enhancement drugs on individual performance may be eroded in a group context. Under some conditions, the negative inter-personal motivational effects may even outweigh the positive effects of enhancement drugs on group performance. Thus, although the enhanced group members may contribute more to the group performance, due to negative motivational effects on non-enhanced group members, the enhancement use during group work may result in a net loss in group performance. Hence, our research suggests that accounting for individual workers' mental states becomes even more important when they frequently work in teams, in order to avoid negative spill-over effects on other team members and to prevent enhancement from decreasing rather than increasing group performance. These findings should also be considered in policy-making, for example, regarding regulations for shift work and long working hours. Moreover, allowing or even encouraging enhancement pills at work—as some scholars have suggested (Bostrom & Sandberg, 2009; Leon et al., 2018; Savulescu, 2006)—might have 'social side effects' that need considering.

4.3 | Limitations and directions for future studies

The present study comes with at least two limitations. First, we used vignette experiments and asked participants about their hypothetical willingness to contribute to group performance. We are fully aware that intended effort does not equal actual behaviour. However, with relatively small attitude-behaviour gaps for behaviours that are easy to implement, we are confident that the reduced willingness reported by our participants is likely to translate into actual behaviour. There

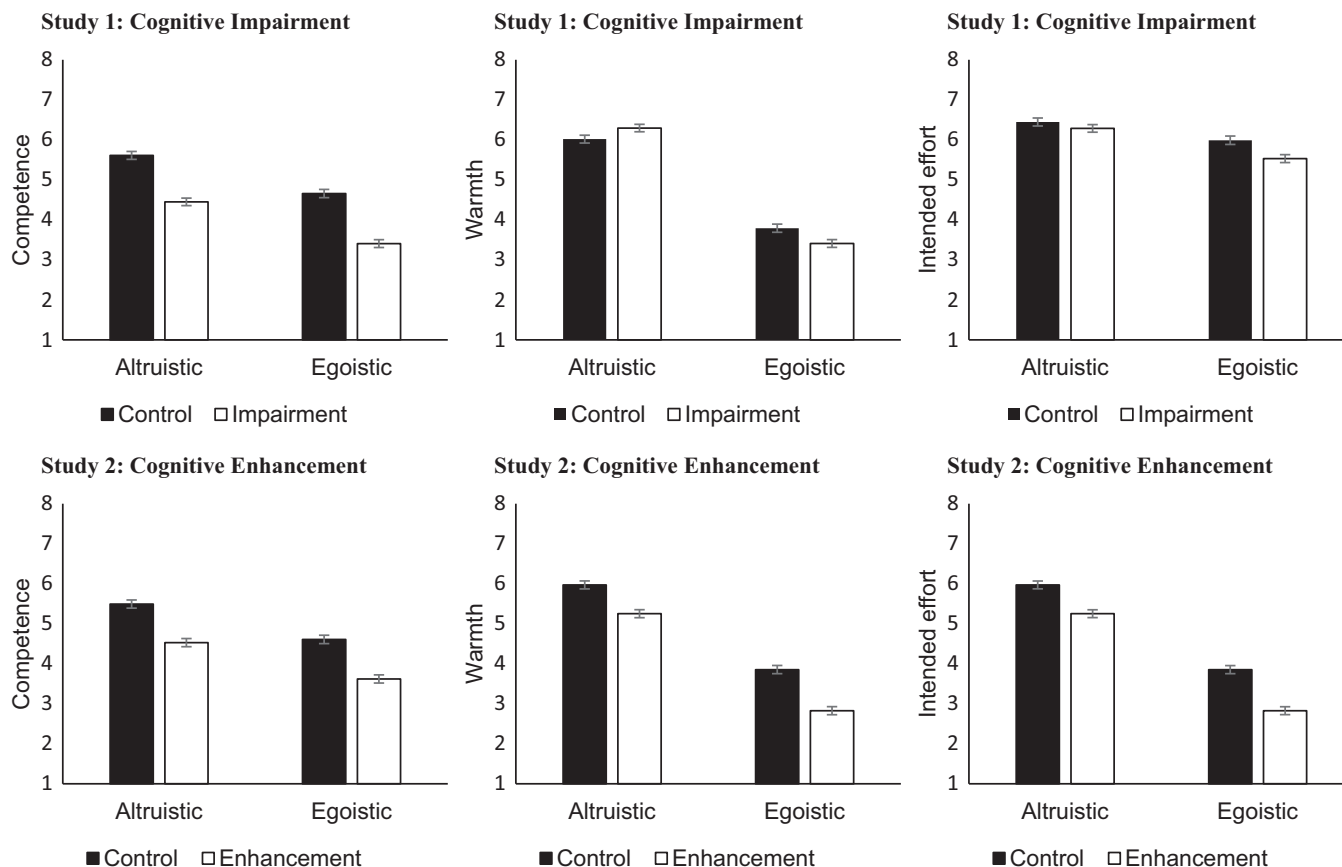


FIGURE 3 Conditional effects of impairment (vs. control) in Study 1 ($N = 1181$) or conditional effects of enhancement in Study 2 ($N = 1171$) on competence, warmth, and intended effort at different levels of reason.

is also evidence that willingness measures substantially correlate with behaviour (Beck & Ajzen, 1991; Pogarsky, 2004), and treatment effects in factorial surveys can be compared to other designs (Hainmueller et al., 2015; Petzold & Wolbring, 2018). Nevertheless, our results should be replicated using real group performance tasks. Second, because our study is the first to investigate how impairment due to sleep deprivation and enhancement of one group member could affect the motivation of other group members, we started with the simplest case of a two-person group. We are aware that natural group composition is very complex with respect to group size and ratio of impaired/enhanced group members. Though we are confident that the key findings from the present studies—impairment and enhancement alters the perception of a group member with downstream consequences for intended effort to contribute to a group task—will translate to larger and more heterogeneous groups, group size and ratio of impaired/enhanced group members might still moderate these effects and constitute important boundary conditions. Future studies would need to investigate how our findings translate into more complex group constellations (e.g., a group with both enhanced and impaired members, or group members with different levels of enhancement/impairment). They may also examine the generalizability of the findings by testing further forms of impairment (e.g., being temporarily or chronically ill), enhancement (e.g., using stimulation devices), and

'normal' mental states as well as explore further reasons for these mental states (e.g., impairment due to genetic reasons or enhancement due to the fear of job loss).

Moreover, future research is challenged to identify moderators and boundary conditions of the effects reported here. In particular, group-specific norms about the use of cognitive enhancement and sleeping behaviour are likely to be a key moderator for the perception of enhanced/impaired group members and the downstream consequences for intended effort to contribute to group performance. For example, while enhancement practices are discredited by the majority of the population (Schelle et al., 2014), there might be groups or individuals with specific characteristics with more positive views about cognitive enhancement (e.g., Machiavellianism or neuroticism; Mayor et al., 2020; Sattler & Linden, 2021; Sattler & Schunck, 2016). In such populations, the use of cognitive enhancers should not be associated with reduced warmth performance.

Finally, in real-life groups heterogeneity not only of mental states but also of socio-demographic variables of the group members might be relevant. In the vignettes used in our study, the colleague was always female. We decided to do so to avoid noise from participants picturing different genders in different conditions due to role expectation (actually, in the pretests we first used a gender-neutral vignette, but doing so in the condition with the egoistic reason of 'buying luxury goods' was

frequently associated with a female gender). Future research should follow up on our studies and account for role expectations and gender composition of the work group.

5 | CONCLUSIONS

In sum, our two experiments provide first empirical evidence that working together in a group with an impaired (sleep deprived) or cognitively enhanced (due to drug consumption) co-worker reduces the willingness to contribute to a mutual task. More negative person perceptions regarding the warmth (in the case of an egoistic reason) and competence of the impaired or enhanced individuals may serve as underlying psychological mechanisms that partially explain these effects. This suggests that groups are more than the sum of their members—or less, when it comes to cognitive impairments and enhancements.

AUTHOR CONTRIBUTIONS

Sebastian Sattler, Jan A. Häusser, and Nadira S. Faber planned the studies and developed the materials; Sebastian Sattler collected and analyzed the data; Sebastian Sattler, Jan A. Häusser, and Nadira S. Faber wrote the article.

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ETHICS STATEMENT

This study was approved by the ethics committee of the University of Erfurt (approval number: EV-20190917). We also adhere to the Code of Ethics of the World Medical Association (Declaration of Helsinki) to protect human research participants.

CONFLICT OF INTEREST STATEMENT

The Authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in institutional repository of Bielefeld University 'PUB Publications at Bielefeld University' (Sattler et al., 2023).

ORCID

Sebastian Sattler  <https://orcid.org/0000-0002-6491-0754>

Jan A. Häusser  <https://orcid.org/0000-0001-8993-9919>

Nadira S. Faber  <https://orcid.org/0000-0001-9373-9549>

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