Behaviour Research and Therapy 103 (2018) 12–17

Contents lists available at ScienceDirect

Behaviour Research and Therapy

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

You make me tired: An experimental test of the role of interpersonal operant conditioning in fatigue

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ARTICLE INFO

Keywords:
Fatigue
Chronic fatigue
Operant conditioning
Interpersonal processes
Working memory

ABSTRACT

Chronic fatigue is highly prevalent in the general population as well as in multiple chronic diseases and psychiatric disorders. Its etiology however remains poorly understood and cannot be explained by biological factors alone. Occurring in a psychosocial context, the experience and communication of fatigue may be shaped by social interactions. In particular, interpersonal operant conditioning may strengthen and perpetuate fatigue complaints. In this experiment, individuals (N = 44) repeatedly rated their currently experienced fatigue while engaging in cognitive effort (working memory task). Subtle social reward was given when fatigue increased relative to the previous rating; or disapproval when fatigue decreased. In the control condition, only neutral feedback was given. Although all participants became more fatigued during cognitive effort, interpersonal operant conditioning led to increased fatigue reporting relative to neutral feedback. This effect occurred independently of conscious awareness. Interestingly, the experimental condition also performed worse on the working memory task. Results suggest that fatigue complaints (and cognitive performance) may become controlled by their consequences such as social reward, and not exclusively by their antecedents such as effort. Results have implications for treatment development and suggest that interpersonal operant conditioning may contribute to fatigue becoming a chronic symptom.

1. Introduction

Humans frequently experience fatigue, for instance after physical and cognitive effort, prolonged wakefulness, stressful situations, and in acute illness. Although usually alleviated after a period of resting or recovery, fatigue may also persist over longer time periods and may lose its association with effort, illness, or resting. Epidemiological studies estimate that 2%–11% of the general population report long-term or chronic fatigue (lasting at least six months; Jason et al., 1999; Kluger, Krupp, & Enoka, 2013; Loge, Ekeberg, & Kaasa, 1998). In one large study (N = 9375) this estimate was even 31% of the general population, possibly due to over half of individuals with long-term fatigue in this sample suffering from a medical condition that may partially explain fatigue symptoms (van 't Leven, Zielhuis, van der Meer, Verbeek, & Bleijenberg, 2009). Indeed, fatigue is also one of the most common symptoms in chronic illness, including cardiovascular, neurological, and immunological diseases (Cumming, Packer, Kramer, & English, 2016; Heesen et al., 2006; Kluger et al., 2013; Stebbings & Treharne, 2010); several psychiatric disorders such as major depressive disorder, generalized anxiety disorder, somatic symptom disorder and attention deficit hyperactivity disorder (Rogers, Dittner, Rimes, & Chalder, 2017); and is a core symptom in chronic fatigue syndrome and fibromyalgia.

Nevertheless, our understanding of the processes that cause and maintain fatigue is largely incomplete. For instance, fatigue and other somatic sensations such as pain or dyspnea may exist in absence of bottom-up physiological or neurobiological dysregulation (Brown, 2004; Rief & Broadbent, 2007). The observation that there is often no simple correspondence between objective physiology and the conscious experience of somatic sensations calls for an integrative approach to illness and health; incorporating biological, psychological, and social processes (Lenaert, Boddez, Vlaeyen, & van Heugten, 2018; Van den Bergh, Witthöft, Petersen, & Brown, 2017). Several variables have indeed been implicated in the etiology of chronic fatigue, including neurobiological and disease specific variables (e.g., Chaudhuri & Behan, 2004; Pardini, Bonzano, Mancardi, & Roccatagliata, 2010), psychological variables such negative or catastrophizing thoughts about fatigue (e.g., Knoop, Prins, Moss-Morris, & Bleijenberg, 2010; Lukkahatai & Saligan, 2013), and environmental factors such as the presence of prolonged stressors (e.g., Wyller, Eriksen, & Malterud, 2009). With

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https://doi.org/10.1016/j.brat.2018.01.006
Received 29 September 2017; Received in revised form 29 December 2017; Accepted 17 January 2018

respect to social processes, there is increasing evidence that fatigue severity and fatigue related disability may be associated with the behavior of significant others of patients with chronic fatigue symptoms (Band, Wearden, & Barrowclough, 2015). For instance, perceived solicitous behavior by significant others has been related to higher fatigue severity and bodily pain among patients with chronic fatigue syndrome (Schmaling, Smith, & Buchwald, 2000), as well as worse levels of disability (Romano, Jensen, Schmaling, Hops, & Buchwald, 2009). Moreover, in a study that combined self-reported perceptions with direct observations of dyadic interactions, solicitous responses by the significant other were also found to predict reported and observed patient illness behaviors such as seeking help and verbally expressing fatigue and pain (Romano et al., 2009). These results indicate that interpersonal operant conditioning may play a role in the context of chronic fatigue. That is, fatigue and fatigue related behavior, such as resting or avoidance of activity, may constitute responses that are reinforced by their outcomes (e.g., temporary relief of fatigue; Lenaert et al., 2018). Similarly, expressing fatigue may be reinforced by receiving care and attention from significant others and health professionals. Reinforcement or reward by the social environment may maintain and strengthen fatigue reporting in the future, whereas it may decrease after social 'punishment' or disapproval (Domjan, 2005). Operant conditioning may thus help explain how reporting fatigue experiences can lose its association with effort or illness and their physiological correlates. Indeed, when successfully brought under operant control, fatigue reporting may become a function of its consequences (e.g., social reward/disapproval), rather than its antecedents (e.g., physical or cognitive effort; illness). Moreover, shaping of behavior by the social environment may be subtle, occurring in multiple interactions over longer time periods, and may therefore escape conscious awareness.

However, the currently available evidence for such operant conditioning account is based on cross-sectional studies, mainly relying on self-reported data about the perceived behavior of significant others (for a review: Band et al., 2015). This precludes conclusions about interpersonal operant conditioning as a (causal) mechanism in the development and maintenance of fatigue complaints. For instance, solicitous significant others may be inadvertently positively reinforcing and strengthening fatigue complaints. Alternatively, the presence of more severe fatigue symptoms may merely elicit more solicitous responding from significant others (Schmaling et al., 2000). Experimental research is necessary in order to assess the direction of this relationship. Surprisingly, there are no experimental studies on (interpersonal) operant conditioning in relation to fatigue. This is in strong contrast to pain research, where several experimental investigations have been based on Fordyce's (1976) theory that pain behaviors such as lying down, groaning, or wincing may be reinforced – and thus maintained – by its consequences, such as temporary relief of pain or attention from others. To the extent that the social environment rewards these pain responses, it may inadvertently contribute to the development of a pattern characterized by chronic pain and disability. In their seminal study, Linton and Götestam (1985) inflated a blood pressure cuff to a painful level on the arm of healthy individuals. Whereas cuff pressure remained constant throughout the experiment, subjective pain reports could be conditioned to increase/decrease by giving verbal praise/punishment to pain reports. Lousberg, Groenman, Schmidt, and Gielen (1996) showed that operant conditioning not only increased pain reporting but also physiological responses to painful stimulation (i.e., skin conductance responding). Interestingly, Jolliffe and Nicholas (2004) showed that awareness of the contingency between pain reporting and reinforcement was not predictive of differences in conditioning effects, suggesting that this learning process may occur independently of conscious awareness. Insights in these (interpersonal) conditioning processes have advanced understanding of chronic pain and have been successfully integrated in its treatment (den Hollander et al., 2010; Gatzounis, Schrooten, Crombez, & Vlaeyen, 2012).

The current experiment investigated how interpersonal interactions may affect subjective fatigue reporting and objective cognitive performance. More precisely, we aimed to bring fatigue reporting under operant control – through social reinforcement – while participants engaged in cognitive effort. Using a demanding working memory task to induce fatigue, subjective fatigue reports throughout this task were either reinforced by the experimenter (if higher than the previous report), or punished (if lower). We hypothesized that this conditioning procedure would result in higher fatigue reporting than in a control condition that only involved neutral feedback. We also investigated whether this effect would occur independently of conscious awareness. As a secondary question, we assessed whether our conditioning procedure also affected cognitive performance during the task. It is possible that not only subjective fatigue increases, but that objective performance also suffers as a result of interpersonal interactions that reinforce fatigue.

2. Method

2.1. Participants

Forty-four participants (40 women) with a mean age of 24.7 years (SD = 7.8) were recruited at Maastricht University, Netherlands. Participants could voluntarily sign up for this study using the university's online research participation system (Sona systems Ltd.) or by responding to an advertisement about this study in the university building. Although there are no previous studies on operant conditioning of fatigue, power analysis determined that this sample size would be sufficient to detect a small to medium-sized effect at 95% power, using $p < .05$. A small to medium effect size was assumed given that our operant conditioning manipulation was deliberately confined to subtle social reward or punishment, in order to mimic as closely as possible how these interactions may shape behavior in daily life situations independent of conscious awareness. Participants had to be 18 years or older to be included in the study. A good comprehension of Dutch language was required in order to participate. Participants were excluded if they reported to be currently suffering from (or diagnosed with) depression, chronic fatigue syndrome, dyslexia, or ADHD, as our fatigue induction requiring prolonged cognitive effort may have proven too burdensome for these individuals. The study was approved by the Ethical Review Committee Psychology and Neuroscience of Maastricht University. All participants gave their informed consent.

2.2. Working memory task

A dual 2-back task with a visual and auditory component was administered using Presentation® software, version 19.0, Neurobehavioral systems (California, USA). During this continuous working memory task, participants were required to actively monitor two sequences of stimuli (Fig. 1, panel a). Auditory stimuli were numbers ranging from 1 to 9 and were presented through headphones. Participants had to monitor whether the number they heard was identical to the number presented two numbers back (i.e., auditory target). Visual stimuli were presented simultaneously, which were black squares presented on the computer screen in one of eight possible places in a three-by-three grid (a fixation cross was presented in the center square of the grid). Similarly, participants had to monitor whether a square was presented in the same place as two presentations before (i.e., visual target). Stimuli were presented for 500 ms. The inter stimulus interval was set to 2500 ms. The task consisted of five blocks of five minutes (100 stimulus presentations per block), preceded by a short practice phase. Each block included eight visual targets, eight auditory targets, four dual targets with auditory and visual target presented simultaneously, and 80 stimulus presentations without a target presented.