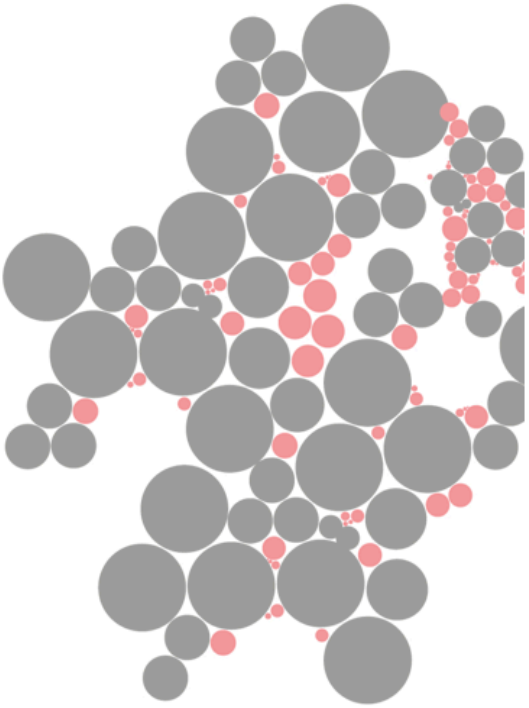

INVESTIGATING THE ROLE OF IMPLICIT PROCESSES REGARDING FATIGUE USING A WORD ASSOCIATION TEST

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Abstract

Objective. In this study, it was investigated to what extent implicit measures are appropriate to measure fatigue, using a Word Association Test.

Method. A Word Association Test was compiled to assess fatigue implicitly. In total, 50 participants filled out the implicit measure, additionally to three standardized explicit measures, a Numerical Rating Scale (NRS), the Vitality/Fatigue subscale of the Research and Development 36-Item Health Survey (RAND-36), and the Checklist for Individual Strength (CIS20R). After the completion of these measures, the participant performed a self-coding on his/her answers on the implicit measure. In addition to this, two researchers coded the answers independently. To assess the coding agreement, an interrater-reliability was applied. Afterwards, the implicit test was correlated with each explicit measure to assess possible relations.

Results. The analysis showed poor to fair interrater-agreement between the three raters. Furthermore, the correlations between the implicit measures and the explicit measures showed no significant relations.

Conclusion. The results gave no indications for implicit testing with regard to fatigue as an appropriate measure. However, more methodologically sound and well-investigated implicit tests could be promising alternative to measure fatigue more accurately and may serve as an addition to the existing standardized explicit measurements.

Introduction

In dictionaries, fatigue is defined as extreme tiredness due to mental or physical exertion or illness (Oxford University Press, 2015). However, studies indicate that fatigue is a broad, multi-layered concept that contains various behavioural and psychological dimensions (Yang & Wu, 2005; Phillips, 2015). For example, fatigue can be seen as an experience including the subjective feeling of being tired and having a lack of energy, ultimately leading to not only physical, but also cognitive impairments (Shen, Barbera, Shapiro, 2006). Furthermore, fatigue is frequently described as a physiological state of depletion with an inability to maintain the level of physical activity, resulting from excessive stress or exertion (Hirschkowitz, 2013; Soames-Job & Dalziel, 2001). Thirdly, fatigue is often regarded as a performance decrement, including cognitive diminishments in attention, perception, and memory (Hancock & Desmond, 2001). Beside these listed definitions, there is a variety of other definitions of fatigue (Phillips, 2015). The diversity of descriptions indicates that the concept fatigue leaves a broad space of interpretation and the unilateral definition of fatigue given in dictionaries needs to be questioned. In order to describe the concept to its fullest, an overarching definition of fatigue, which includes all of its facets, is necessary.

Due to the variety of definitions and its multidimensional character, it is questionable whether participants of fatigue related surveys interpret the concept of fatigue similarly, depending on factors like context and prior experience. Different conceptions among participants could possibly lead to different interpretations of items and ultimately result in less reliable results. However, research with regard to different interpretations of the concept fatigue is little and needs to be further investigated.

As a possible symptom of medical conditions and psychological disorders, as well as a lasting condition on itself, fatigue can cause severe harm including limitations in daily functioning and high costs for society. Studies indicate that 38% of the general community in England reports problems with fatigue, whereas in the US 35% has problems with this condition (Afari & Buchwald, 2014; Pawlikowska, Chalder, Hirsch, Wallace, Wright & Wessely, 1994).

Symptoms that go along with fatigue, such as a decrement in physical activity and attentional impairment, do not only lead to problems on an individual level, but also to problems that affect the society. It is evident that patients diagnosed with lasting fatigue problems suffer from impairments in daily functionality including a decrease in social relationships and severe problems at work (Afari & Buchwald, 2014). One explanation for these impairments might be the fact that physical inactivity is a consequence of fatigue and vice versa, which ultimately results in a reduced productivity (Hughes, Crow, Jacobs Jr., Mittelmark, & Leon, 1984). A study from Reynolds and colleagues (2004) for example, estimated that patients with lasting fatigue have an individual annual economic loss of approximately $20,000, due to their illness. Furthermore, they determined that on societal level chronic fatigue problems cause an annual national loss of $9,1 billion. Summarized, fatigue is a commonly known problem that not only affects individuals, but also society. Based on this, the need to find solutions to reduce the harms caused by fatigue is evident.

In order to fully understand and improve problems regarding fatigue, it is helpful to shortly discuss its determinants. Besides biochemical processes, demographic variables such as age and gender play a role in the process of fatigue, as well as weight and especially obesity (Dunlap, Loros, & DeCoursey 2004, Cardol, Bensik, Verhaark, & Bakker, 2005; Vgontzas, Bixler, & Chrousos, 2006). The

amount of physical exercise, as well as mental effort and psychosocial stress during the day determine when and to what extent fatigue occurs. Furthermore, individual factors as height and weight, previous sleep deprivation, and the consumption of stimulants as nicotine and caffeine contribute to the level of wakefulness (Irish, Kline, Gunn, Buysse, & Hall, 2014). However, due to its multi-layered quality, there may be other important causing factors involved in the process of fatigue that are not known yet. Research with regard to the role of cognitive processes in fatigue is little and might be promising to gain more insight in the whole scope of fatigue, to ultimately contribute to the treatment of fatigue related disorders.

To determine whether a person has problems regarding fatigue and to apply possible treatments, adequate measuring instruments are needed to provide a valid and reliable measure. In general, there are four ways to measure fatigue, namely subjective measures (self-evaluations), performance decrease measures, sleep propensity measures, and arousal decrease measures (Kamiya, 1961). Most commonly, subjective self-evaluations as the Stanford Sleepiness Scale (SSS; Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973), the Fatigue Severity Scale (FFS; Krupp, LaRocca, Muir-Nash, & Steinberg, 1989), and the Multidimensional Assessment of Fatigue Scale (MAF; Belza, Henke, Yelin, Epstein, & Gilliss, 1993) are used. Furthermore it is possible to use survey subscales, for example the fatigue/vitality subscale of the Research and Development 36-Item Health Survey (RAND-36; Hays & Morales, 2001). It is notable that various explicit measurements request different time periods on which basis respondents have to answer. Items of the RAND-36, for example, have regard to the past few weeks, whereas the SSS requests different levels of alertness during one day. It is uncertain to what extent time specifications in existing measures of fatigue alter respondent's interpretation of the concept. In a

study from 2005, Wang & Yu proposed that time specifications are crucial that respondents give specific answers and do not rely on general estimations of their feelings with regard to their state fatigue. Therefore, it seems that different time specifications could elicit different dimensions of the concept fatigue and need to be taken into account.

In a study from 2001 Curcio, Casagrande, & Bertini found that the various explicit measurements of fatigue have several limitations. They found a different sensitivity to fatigue and the amount of previous sleep to be an important moderating factor. Furthermore, self-evaluation and social desirability bias of participants often leads to less reliable results (Shen, Barbera, Shapiro, 2006). Showing that existing measures do not measure the phenomena of fatigue appropriately, other, more reliable ways of measurement have to be found. Therefore the question of how to measure fatigue independently and without biases arises.

Until now, fatigue is only measured through explicit measures, for example self-evaluations that are prone to the influence of biases such as social desirability. In similar fields like self-esteem, it has shown to be effective to have a look at processes that play an unconscious role, to avoid the limitations of explicit measuring methods (Glashouwer & Jong, 2008; Risch, Buba, Birk, Morina, Steffens, & Stangier, 2010; Rudman, Phelan, & Heppen, 2008). As yet, there is no research with regard to implicit processes of fatigue. Consequently, there may as well be processes within the concept of fatigue that are not measurable by means of explicit measurements, because they are not consciously retrievable. An implicit testing based on the dual-process theory, which measures unconscious processes, may provide more accurate measures of fatigue due to its reduced sensitivity to biases, and may include more aspects of the concept fatigue.

The dual-process theory of reasoning assumes that information is processed in two different ways through two distinct systems that work parallel and interact with each other (Epstein, 1994). One system, called the 'rational system', comprehends information consciously and with reason. It is analytical, establishes logical connections, and is experienced actively. The 'experiential system' on the other hand, acts unconsciously and is driven by affect. Its holistic and associative approach leads to broader and more context specific views (Epstein, 1994; Evans, 2008). Associated with these two systems are the concepts of explicit and implicit cognition. Related to the rational system, explicit cognitions are assumed to be controlled, accessible to conscious reasoning, and can be assessed by introspection and explicit measures as questionnaires. Like the experiential system, implicit cognitions are automatic, unconscious, and thus not available to assess via introspection (Rooke, Hine, & Thorsteinsson, 2008). Until now, research has strongly focused on the explicit side of fatigue, which measures have implications such as a different sensitivity to sleepiness and a proneness to social desirability bias (Curcio, Casagrande, & Bertini, 2001). Therefore the relevance of implicit processes should be taken into account, as well as an implicit testing that may provide a more accurate measure of fatigue.

A meta-analysis by Rooke et al. (2008) has shown that in a variety of behaviours, like for instance substance abuse, implicit testing has been implemented successfully and has served as an additional method to identify and treat users at risk. On the contrary, there is little research regarding the role of implicit testing in the field of cognitions. A few studies that investigated attitudes and self-esteem, however, have shown that it is effective to not only focus on the explicit side, but also to consider implicit processes (Rudman, Dohn & Fairchild, 2007; Rudman, et al., 2007). Similarly, an implicit approach might also help to gain more insight into the concept

fatigue through revealing possible aspects of fatigue that are not known yet. Furthermore, it might reduce possible biases that play a role during explicit testing.

Amongst other things, benefits of an implicit approach are a reduced sensitivity to biases, especially social desirability, which is a problem in explicit testing, as well as the possibility to assess cognitive processes that may not be accessible for introspection to assess the whole concept of fatigue (Wiers & Stacy, 2006). In order to diminish the implicications that occurred during explicit measuring as described beforehand, and to obtain a more accurate measurement, an implicit testing of fatigue might be promising. Furthermore there is no research on the role of implicit processes in fatigue yet.

One of the most frequently used implicit measures to assess implicit association in cognition is word association. In a word association test, a respondent is given a word as a stimulus, to which he/she has to respond with the first word that comes in his/her mind. Based on the answers, it is possible to predict cognitive responses that are attributable to implicit processes during certain behaviours and states (Stacy, Ames, & Grenard, 2006). Word association has been successfully used in behavioural fields like substance abuse. For example, in a study from 2007 Ames and colleagues found that word association was a significant predictor of marihuana use and accounted for more variance than similar implicit tests as the Implicit Association Test (IAT). The appropriate measuring of fatigue is the first step to treat people who are suffering from fatigue-related problems adequately. Therefore, implicit testing of fatigue might help to obtain a reliable, overarching measure, ultimately leading to treatment improvement for people in need.

To examine the research question *Are implicit measures appropriate to measure fatigue?*, a word association test is compiled and compared to existing

explicit measures. Due to the multidimensional character of fatigue, one of the main aims of this study is to investigate whether different raters interpret the concept fatigue in the same manner. An interrater-reliability between three raters is conducted, in order to determine the degree of agreement on the concept of fatigue and its various dimensions. Although fatigue contains different (sub-)dimensions, a high interrater-reliability is expected, because all dimensions fall in the comprehensive concept fatigue. Next to this, a main aim of this study is to investigate to what extent the constructed implicit test measures fatigue validly. By this means, a high correspondence between the constructed word association test and existing standardized explicit measures that have shown to be valid, is expected. To find out whether time specifications have influence on the respondents perception of fatigue, two different time periods are requested. The following hypotheses are going to be tested:

1. The interrater-reliability between the self-coding of the respondents and the coding of the researcher is high ($\kappa > 0.60$)
2. The results of explicit measurement regarding the momentary state of fatigue (NRS) and the results of the Word Association Test correlate highly ($r \geq 0.7$)
3. The results of explicit measurements regarding the state of fatigue during the past weeks (RAND-36, CIS20R) and the results of the Word Association Test correlate highly ($r \geq 0.7$)

Methods

Participants

The sample of this study was selected by using two different sampling methods: Convenience sampling and snowball sampling. Including criteria were students, who had to be over 18 and could speak English on a university-level. In order to gather respondents, students of the University of Twente were asked face-to-face or via social media to participate in this study. The students asked to participate were mainly friends and acquaintances of the researchers and were part of their direct social contacts. Using snowball sampling, those students as already existing study subjects, were asked to recruit further subjects from among their acquaintances. Finally, for all students of the University of Twente, it was possible to apply for the study via SONA, an online-subscribing research website of the University of Twente with their student accounts and by participating in the study gain obligatory reward points which are credited on their student account (utwente.sona-system.com). However, only 3 participants were recruited through the online subscribing service SONA. In total, 50 respondents participated in the study, of which 56% were male and 44% were female. The age varied from 18 to 28, with a mean of 22.80 and a standard deviation of 1.88.

Measurement Instruments

In total, the pen-and-paper questionnaire (see appendix B) consisted of four different parts. Firstly, the respondent was given instructions and was afterwards asked to provide information over his/her age and gender. Secondly, two different implicit association tests, one word association test and one sentences completion test were taken to evaluate subconscious processes with regard to fatigue. In this study, only the word association test will be examined, as the sentence completion test is part of

another bachelor thesis, which used the same data collection process. To avoid bias, the order of the two implicit tests, as well as the items of the two tests, was presented randomized. Thirdly, three different explicit measurements were used to assess fatigue via self-report. The explicit measurement methods contained a numeric rating scale (NRS), the energy/vitality subscale of the Research and Development 36-Item Health Survey (RAND-36), and the Checklist for Individual Strength (CIS20R). It was chosen to first present the implicit tests, followed by the explicit tests, to not reveal the subject beforehand. Lastly, the participant needed to classify his/her answers on the implicit tests, if applicable, on the basis of three different categories.

Word Association Test (WAT). A word association test was compiled by the two researchers to assess the participant's attitudes and cognitions towards fatigue and how he/she reacts to ambiguous words with regard to fatigue. Participants were instructed to respond to the stated words with the first word that comes in mind. The test consisted of 20 randomized items, including ten ambiguous words that might evoke associations related to fatigue, and ten control items. Before compiling the test, existing studies in the field of substance abuse including word association tests were reviewed to investigate the process of assembling suitable words (Ames, Zogg, & Stacy, 2002; Rooke, Hine, & Thorsteinsson, 2008). For the ambiguous part, words, which have a distinct relation to fatigue, like for example activities that take place prior to sleep (*reading, television*), activities that are related to physical exhaustion (*workout, shopping, exam*), objects / concepts related to sleep (*alarm clock, blanket, morning),* and words with a relation to vitality (*energy, battery)* were used. Furthermore, ten control items without any relation to fatigue or sleep (for example *tree, house, table*) were included, so that it is possible to draw comparisons. Afterwards, an expert in the field of measuring implicit processes evaluated the test

and judged it as adequate. Before the questionnaire was given to the respondents, it was pilot tested.

Sentence Completion Test. The second test that was used to measure fatigue implicitly is a sentence completion test. The sentence completion test works in a similar manner as the WAT, but uses incomplete sentences instead of single words to evaluate a person's cognitions.

Numeric Rating Scale (NRS). The first explicit test that was used to evaluate fatigue is a numeric rating scale. In order to assess the momentary state of fatigue, the participant was asked to set a cross on one number on a given scale. The numeric rating scale ranges from 0 to 10, with the low extreme "not tired at all" (0), to the high extreme "very tired" (10). Studies in the field of pain have shown that the visual rating scale is a valid measurement and participants find it easier to use and are more responsive to a VRS than to comparable scales, like visual analogue scales, or verbal rating scales (Ferreira-Valente, Pais-Ribeiro & Jensen, 2011; Hjermstad, Fayers, Haugen, Caraceni, Hanks, Loge, et al., 2011).

Research and Development 36-Item Health Survey (RAND-36; Energy & Vitality scale). Secondly, the Energy & Vitality subscale of the RAND-36 was used, which evaluates the participant's fatigue during the last four weeks (Hays & Morales, 2001). It consists of seven items, which are supposed to be answered on a six-point Likert scale. The participant was asked to indicate how often during the last four weeks he/she had been feeling in the stated ways. The Energy & Vitality subscale of the RAND-36 was used in this study, because in prior research it had shown to have a high reliability, with $\alpha = 0.82$. Furthermore, the RAND-36 is a valid instrument with high sensitivity, indicating good psychometric qualities (VanderZee, Sanderman, Heyink, 1996).

Checklist Individual Strength (CIS20R). To assess fatigue during the last two weeks with another instrument, participants were at last asked to complete the CIS20R (Vercoulen, Alberets, & Bleijenberg, 1999). The CIS20R is a 20-item self-report questionnaire and evaluates the level of fatigue during the last two weeks. It is composed of four subscales, namely, *Subjective Feeling of Fatigue, Concentration, Motivation,* and *Physical Activity*. Participants were asked to indicate how often the given statements applied to how they had felt during the past two weeks on a seven-point Likert scale. Prior studies have shown that the CIS20R shows a high reliability with a Cronbach's $\alpha = 0.90$ and holds a sufficient discriminant, as well as convergent validity. Due to a good psychometric quality, this scale was used (Beurskens, Bültmann, Kant, Vercoulen, Bleijenberg & Swaen, 2000).

Self-coding. At the end of the questionnaire, the participant received the instruction to classify his/her answers on the implicit tests. On the basis of his/her own interpretation, the participant had to categorize every given answer on every item of the implicit tests into one of three categorizations, namely "*associated with fatigue*", "*associated with vitality*", or "*not associated with one of these terms*". Indication takes place by setting a "+" for "*associated with fatigue*", a "-" for "*associated with vitality*", and a "0" for "*not associated with one of these terms*" beside each given association. This process simplified the interpretation of the particular, possibly ambiguous association of the respondent, and served as a comparison-method for the objective coding of the researchers. Hereby, misinterpretations on the side of the researchers could be avoided.

Procedure

Test conditions. The study took place in a quiet room in the library of the University of Twente. During the testing, only the two researchers and the respondent were present to avoid interruptions and to guarantee the best possible test conditions. Participants that were gathered via face-to-face request or social media, made an appointment for the test with the researchers. Respondents that applied for the study via utwente.sona-system.com could choose between different time slots. The duration of the whole test procedure was scheduled for 30 minutes. Ultimately, the duration of the test procedure was approximately 5 minutes shorter.

Test process. Before test start, the respondent received an information sheet and an informed consent regarding anonymity and privacy of his/her personal data (see appendix A). With agreeing on the informed consent, the respondent received the pen-and-paper questionnaire. On the first page of the questionnaire, the participant could find instructions with regard to test procedure and order of the questionnaires. Following the order of the questionnaires was mandatory to avoid priming. The respondent received sufficient time to read the instructions and, if questions arised, to ask the researchers. Additionally, the participant was told that during the testing, it is allowed to ask questions regarding test procedure, but not regarding the content of the questionnaires. If all potential questions were answered, the respondent started with first part of the questionnaire. After completing the questionnaire and the self-coding, the respondent received a full debriefing about the aim and context of the study by the researchers.

Debriefing. During the debriefing the participant was told the aim of the study and got the information that the two implicit tests contained control items, as well as ambiguous items. On the basis of the frequency of associations that are related to

fatigue and vitality, the participant's attitude towards these constructs would be estimated. The aim of self-coding was to determine whether the associations of the respondent had regard to fatigue or vitality or had no regard to the two terms at all. Furthermore it served as a control method for the researchers.

Data Analysis

All statistical analysis used in this study was executed via IBM's software package SPSS (Statistical Package for Social Sciences) version 21, except for the interrater reliability, which was executed manually. Prior to the main analysis, all relevant variables were tested for normality using the Saphiro-Wilk Test, as it seemed to be the most powerful one among normality tests (Razali & Wah, 2011, see table 1). For variables with a normal distribution, Pearson´s correlation coefficient was used; for variables that do not have a normal distribution, Spearman's rank correlation coefficient (rho) was applied. Descriptive statistics (mean, standard deviation, & range) were calculated for all scales. For all variables that were not normally distributed, the median was calculated additionally to the mean, because it happened to be a more robust measure for not normally distributed data (Pappas & DePuy, 2004).

Table 1

Test of Normality of the WAT (Fatigue, Vitality, & Sumscore), the NRS, the RAND-36, & the CIS20R

	Shapiro-Wilk		
	Statistic	df	Sig.
WAT Fatigue	.963	50	.124
WAT Vitality	.906	50	.001
WAT Total	.950	50	.036
NRS	.937	50	.010
RAND	.934	50	.008
CIS	.965	50	.150

Implicit tests. The data analysis of the implicit tests contained several singular steps. The first step had regard to the coding of the given answers on the particular item. The answers were coded into three different categories by the participant him/herself and the two researchers independently. The coding took place by categorizing every particular answer into one of the three categories: "*associated with fatigue*", "*associated with vitality*", and "*not associated with one of these terms*", for which sum scores were calculated. Additionally, a total score of the sum scores of the two classifications *fatigue* and *vitality* was compiled. Afterwards, an interrater-reliability analysis using Cohen's Kappa was executed, in order to assess the correspondence of the coding between the raters. The qualitative data obtained through the associations given by the respondents in the WAT was therefore, by means of the coding, analysed quantitatively.

Explicit tests. In order to assess the correspondence between the three explicit measures, correlations between the NRS and the RAND-36, between the NRS and the CIS20R, and between the RAND-36 and the CIS20R were executed.

Correlation explicit & implicit tests. In total, nine correlations were calculated between the WAT and the three explicit measures to find out possible relationships. For every correlation, the coding of the respondents was used, given that it might show the highest degree of validity. The *fatigue,* respectively *vitality* scores*,* as well as the sum score of both classifications of the word association test, were correlated with the scores of each particular explicit scale (WAT - NRS, WAT - RAND-36, WAT - CIS20R).

Results

Descriptive Statistics

The results of descriptive statistics of all used measurement instruments are displayed in table 2. Analysis of the Fatigue/Vitality subscale of the RAND-36 revealed a lower mean and standard deviation (M = 59.70, SD = 17.77) in comparison to the scores of a Dutch sample in the age of 18-24 (M = 69.2, SD = 18.6) determined in a study of van der Zee & Sanderman (2012), indicating a lower level of vitality. A considerably higher mean of the scores of the CIS20R was found (M = 96.96, SD = 14.73) compared to a study from Vercoulen et al. (1999), who found a mean of 41.5 (SD = 19.7) in the healthy Dutch population, indicating a higher level of fatigue in the present sample.

Table 2

Descriptive statistics of all used measurement instruments (Fatigue, Vitality, & sum score of the WAT; NRS; RAND-36; & CIS20R)

	WAT Fatigue	WAT Vitality	WAT Total	NRS	RAND	CIS
Mean	3.60	2.86	6.46	4.48	59.70	96.96
Median	3.50	3.00	7.00	4.00	65.00	98.00
Std. Deviation	1.76	1.62	2.19	2.31	17.77	14.73
Range	8.00	8.00	10.00	10	65.00	59.00
Minimum	.00	.00	.00	0	20.00	62.00
Maximum	8.00	8.00	10.00	10	85.00	121.00

Interrater-Reliability

For both presented coding-classifications of the associations given in the WAT, "*fatigue"* and "*vitality",* an interrater-reliability analysis between researcher 1, researcher 2, and the respondents was manually executed (see figure 1). For the interpretation of the κ-value, Altman's (1991) classification was used. The analysis using Cohen's Kappa (κ) showed fair interrater-reliabilities (.2 < κ < .41) between all three raters for the *fatigue* classification. For the *vitality* classification mostly poor interrater-reliabilities (κ < .21) were found. Interrater-reliability analysis of the sum score of both classifications showed poor to fair interrater reliability between the three raters. Analysis furthermore revealed that especially the items "reading" and "workout" led to no agreement between the three raters, with no κ-value above 0.2. The item "blanket", on the other hand, showed high κ-values all above 0.6, indicating a good agreement between the raters.

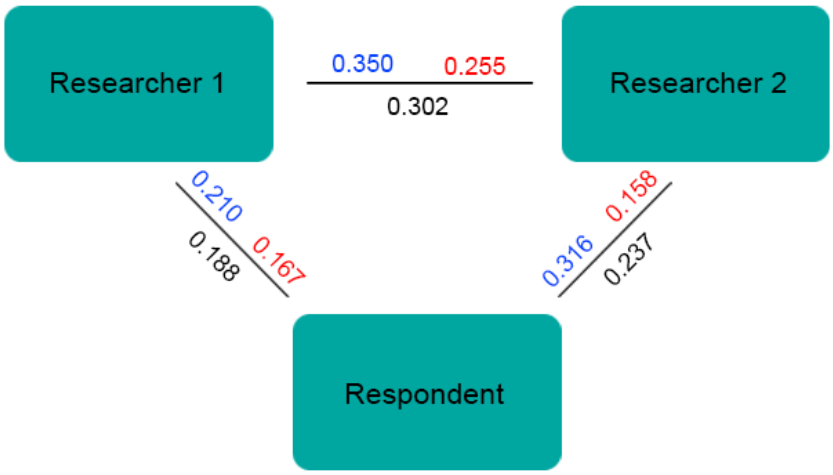

Figure 1. Interrater-reliability of the classifications "fatigue" (blue), "vitality" (red), and the sum score of both (black) within the WAT (in κ).

Correlation Explicit Measures

Analysis of the used explicit measures using Spearman's rho revealed a moderate, but not significant negative correlation between the NRS and the RAND-36 ($r(50) = -0.133$, $p > 0.05$). The correlation between the NRS and the CIS20R is moderate, negative, and significant ($r(50) = -0.427$, $p < 0.05$). Between the RAND-36 and the CIS20R, a strong and significant correlation was found ($r(50) = -0.659$, $p < 0.05$, see figure 2)

Correlation Implicit – Explicit Measures

WAT - NRS. To investigate possible relations between the WAT and the NRS, the sum scores of both measures are correlated using Spearman's rho. Analysis showed no significant correlations between the *fatigue,* the *vitality,* and the sum score of both classifications of the WAT and the scores of the NRS (see figure 2).

WAT - RAND-36. Correlation between the *fatigue* classification and the sum score of both classification of the WAT and the RAND-36 showed no significant relations. However, a moderate, significant correlation between the WAT's *vitality* classification and the RAND-36 was found ($r(50) = 0.386$, $p < 0.05$; see figure 2).

WAT - CIS20R. Pearson's correlation coefficient was used to assess possible relations between the *fatigue* classification of the WAT and the sum score of the CIS20R. Analysis revealed no significant correlation. For the correlation between the *vitality* classification and the sum score of both classifications of the WAT and the CIS20R sum score, Spearman's rho is calculated, which shows no significant correlations (see figure 2).

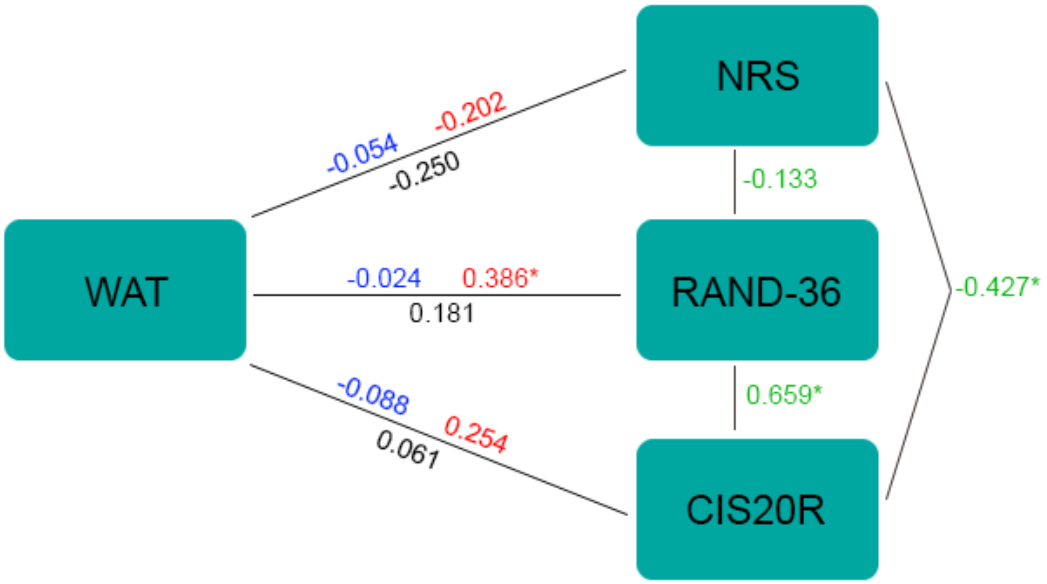

Figure 2. Correlations between the used explicit measures (green): NRS, RAND-36, and CIS20R & Correlations between the explicit and implicit measures: "fatigue" (blue), "vitality" (red), the sum score (black) of the WAT, and the NRS, the RAND-36, and the CIS (in *r*). Significant correlations are displayed by a "*" beside the value.

Discussion

Main Findings

The results showed no indications for implicit tests to be adequate methods to measure fatigue, negating the main research question of this study, *"Are implicit measures appropriate to measure fatigue?*". It has been evident that the constructed implicit measure, the word association test, did not measure the construct of fatigue as the explicit tests, and the items used in the WAT were not useable.

Analysis has shown that there was no high interrater-reliability ($\kappa < 0.60$) between the researchers and the respondents, as well as between the researchers themselves; therefore rejecting the first hypothesis. The second hypothesis can be rejected as well, as no high correlation between the constructed implicit measure (WAT) and the explicit test measuring the momentary state of fatigue (NRS) was found ($r < 0.7$). Lastly, the results disconfirmed the third hypothesis by indicating low correlations ($r < 0.7$) between the constructed implicit measure (WAT) and the two explicit tests that measure fatigue during the past weeks (RAND-36 & CIS20R). However, one moderate significant correlation between the *vitality* classification of the WAT and the RAND-36 was found. In summary, there were no correlations found that would support the developed hypotheses, as well as only moderate agreement between the raters. This might have several reasons.

Firstly, the concept of fatigue is multi-layered. It contains several dimensions, such as the subjective feeling of tiredness, physiological exhaustion, a reduced sense of performance, or psychological exertion (Dobryakova, DeLuca, Genova, & Wylie, 2013; Kushida, 2012). Due to the variety of dimensions, every person might interpret the concept of fatigue differently, leading to various individual ideas of the contents within fatigue. During the coding of the items of the WAT, participants and

researchers had to classify the given associations on the basis of their subjective interpretation. The interpretation of the concepts *fatigue* and *vitality* might have differed from person to person, because due to a minimum of steering, previously no information about the concepts was presented. Therefore, every person had to rely on his/her own experience with the concepts. Different conceptions of fatigue can also be seen in studies that try to discuss and distinguish the various terms often used as synonyms for fatigue, such as "sleepiness" or "tiredness" (Chervin, 2000; Seidel, Hartl, Weber, Matterey, Paul, Riederer, et al., 2009). With various different definitions, these studies show that there is no definite consensus on the meaning of these interrelated concepts. Ultimately, the different interpretations of respondents of the concepts could have led to the low agreement between the raters.

Furthermore, respondents in this study reported on several occasions that they interpret vitality as not to be related to fatigue. This raises the question to what extent vitality is a dimension within the concept of fatigue. In the RAND-36, vitality and fatigue are seen as one interrelated concept, reflected in one subscale with low scores indicating a low level of vitality and simultaneously a high level of fatigue (van der Zee & Sanderman, 2012). The finding of a significant correlation between *vitality* of the WAT and the RAND-36 would rather support the claim that vitality is a similar concept as fatigue, as the used subscale of the RAND-36 measures vitality. However, it seems that the distinction between *fatigue* and *vitality* is not clear, which could have been an additional contributor to the low rater-agreement.

Secondly, the poor correlation between the implicit and explicit measures might be a result of their different measuring qualities. Explicit tests measure attitudes and beliefs of which the participant is aware of, whereas implicit tests measure unconscious processes that are not accessible for introspection. The two measuring

approaches may measure two completely different things, as unconscious processes that play a role within fatigue are completely unknown and may not have any relations with the processes or beliefs that are present in explicit testing of fatigue. Although the implicit measurement does not measure the same aspects of fatigue as the explicit methods, it may measure other sections of the multi-layered concept fatigue. Therefore, it would be possible that due to the different measuring qualities, explicit and implicit tests measure different dimensions of fatigue, as described beforehand. Similar results were found by Lemmens, Roefs, Arntz, van Teeseling, Peeters, & Huibers (2014) who did research in the field of implicit testing of self-esteem. In this study, no relevant correlations that would support the hypotheses between implicit and explicit measures were found, assuming the implicit approach not to measure validly, or measuring different aspects of fatigue that are not included in the explicit testing. There are, however, studies in similar fields like self-esteem that successfully found significant correlations between implicit and explicit measures (Risch, et al., 2010; Glashouwer & Jong, 2008). This shows that, at least in the field of self-esteem, it is possible to adjust an implicit test in such a way that it measures the same constructs as an explicit test.

Thirdly, the constructed implicit measure requests one-word-associations, which are rather general and may not correspond to the specific questions asked in the explicit measures, resulting in a low correlation. However, the low correlations may not mandatorily mean that the WAT does not measure fatigue correctly. In general, the implicit method left more space for interpretation for the respondents and reduce the steering that goes along with the specific questions asked in the explicit measures.

As opposed to the explicit tests, there is no time reference given in the WAT. Analysis of the explicit measures showed that the RAND-36 and the CIS20R

correlate highly, which may be a result of their similar measuring qualities regarding the requested time reference. The correlations between the RAND-36 respectively CIS20R and the NRS, which maintain different time references, were weaker. Looking at the WAT, the participants might have responded to the WAT with more general associations, without any time references. This might indicate that, independent of the used test, at least the same time period is crucial. These results would support the findings of Wang & Yu (2005), who suggested that time specifications are crucial to obtain specified rather than general answers.

Lastly, a factor that might play a role in the poor correlation between the implicit test and the explicit measures, are the indistinct instructions that go along with the creation of a word association test. There are no proper scientifically based instructions of how to compile an adequate word association test for measuring a specific concept. The construction of the ambiguous items was based upon the subjective assessment of the researcher. This may have led to items that are neither valid nor reliable, and therefore to no significant relations between the measures. However, it is to note that the WAT was created under the supervision of an expert in the field of implicit tests, and existing WATs were reviewed beforehand.

Limitations

During the self-coding, a few respondents mentioned that the instructions were not clear, and especially had to ask for further information with regard to the content of the classifications. The, for the respondents unclear instructions of the self-coding, could be a reason for the low interrater-reliability between researchers and participants, as the respondents might have executed the self-coding differently.

Furthermore, the subdivision of the coding into *fatigue* and *vitality* might have led to misunderstandings and complicated not only the coding-process, but also the understanding of the concept fatigue. It has shown to be difficult for several participants to distinguish between these constructs, because on the one hand they show similar aspects, and on the other hand they could be interpreted as opposites.

Lastly, the present study had several methodological limitations including measurement instruments and the used sample size. There was a lack of scientific basis within the construction of the implicit measure, which may have resulted in a poor validity of the WAT, as mentioned beforehand. Even though an expert supervised the creation of the implicit test, there is too little research regarding implicit processes of fatigue and only vague instructions for the construction of a word association test exist. The sample size of N = 50 used in this study was too restricted to obtain representative results; wherefore a larger sample size would be mandatory. It may as well be possible that the sample was too homogenous, because it purely consisted out of students, who were gathered through convenience and snowball sampling, and possibly have similar habits. The results have shown that participants of the used sample are considerably more fatigued in comparison to samples in other studies. Therefore, a more representative sample, which does not only include students, might lead to more reliable data. Additionally, several participants were psychology students, who may have known about the methodology used in this study and were therefore biased.

Future Research

This research has raised the question to what extent implicit tests measure the same aspects of a given concept as explicit tests. It is unsettled, whether the WAT, which

was constructed under the supervision of an expert, does not validly measure the concept fatigue, or solely measures different aspects of fatigue than the used explicit tests. Therefore, it is necessary for future research to clarify and define the concept of fatigue with all its facets. As reviewed beforehand, the definitions of fatigue and its seemingly interrelated terms (sleepiness, tiredness, etc.) are not identical among various studies. However, with a clear and scientifically based definition of fatigue, it might be possible to adjust the items of the WAT in such a way that it measures fatigue validly. For this purpose, it would be reasonable to identify as much dimensions within fatigue as possible, and assemble them into an overarching definition.

Another important factor that has to be improved is to obtain more detailed instructions for the construction of a valid implicit test that measures fatigue correctly. Therefore, more research in the field of the construction of word association tests with regard to specific cognitive states is necessary. Due to their different qualities, existing word association tests regarding behaviors like substance abuse do not seem adoptable for the field of cognitions. Guidelines for the construction of word association tests for specific concepts would contribute to its validity and would ensure their reliability. However, specific cognitions may comprehend specific, unique qualities, wherefore establishing general guidelines might be challenging.

Furthermore, in such a new field of research, it might be more effective to focus on just one concept, *fatigue*, and not to include *vitality*, as it was a confusing factor for the respondents. More detailed and better-tested coding instructions should be developed to avoid misunderstanding, and to enhance the whole coding process.

Conclusion

The results of this research showed no support for the claim that implicit measures are appropriate to measure fatigue. Nonetheless, it is questionable whether the used explicit instruments measured the same dimensions of fatigue as the constructed implicit measure. Therefore, a more methodologically sound implicit test, using a clear definition of fatigue could be an improvement to measure fatigue more accurately. Furthermore, with an enhanced coding-system and more comprehensible instructions, the interrater-reliability could be improved, leading to more reliable data. Lastly, it is necessary to study the underlying implicit processes of fatigue in general, to create reliable und valid instruments in order to help people, who suffer from fatigue related problems.

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Appendices

Appendix A

Information Sheet & Informed Consent

UNIVERSITY OF TWENTE.

Study Information Sheet

Title of Project:	Measuring psychometric quality	**Ethics Approval Number:**	15155
Investigator(s):	Dion Schlesiger Janis Sundermann	**Researcher Email:**	d.h.schlesiger@student.utwente.nl j.h.sundermann@student.utwente.nl

Aims of the Study:
Measuring of psychometric quality of a questionnaire

Eligibility Requirements:
Students over 18, able to speak English

What you will need to do and time commitment:
Completion of a questionnaire, including self-report measurements. The whole test procedure will endure approximately 30 minutes.

Confidentiality of your data:
All data will be treated anonymously and will not be published

Details of any payments/credits (*must be approved by ethics committee)*
0,5 SONA credits

Remember that participation in this research study is completely voluntary. Even after you agree to participate and begin the study, you are still free to withdraw at any time and for any reason.

If you would like a copy of this consent form to keep, please ask the researcher. If you have any complaints or concerns about this research, you can direct these, in writing, to the secretary of the Ethics Committee Faculty Behavioral Sciences of the University of Twente, J. Rademaker (phone: 053-4894591, e-mail: j.rademaker@utwente.nl, Postbus 217, 7500AE Enschede)

UNIVERSITY OF TWENTE.

RESEARCH INFORMED CONSENT FORM

Title of Project:	Measuring psychometric quality	**Ethics Approval Number:**	15155
Investigator(s):	Dion Schlesiger Janis Sundermann	**Researcher Email:**	d.h.schlesiger@student.utwente.nl j.h.sundermann@student.utwente.nl

Please read the following statements and, if you agree, initial the corresponding box to confirm agreement:

	Initials
I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.	
I understand that my data will be treated confidentially and any publication resulting from this work will report only data that does **not** identify me.	
I freely agree to participate in this study.	

Signature:

Name of participant (block capitals)	Date	Signature
Dion Schlesiger Researcher 1 (block capitals)	Date	Signature
Janis Sundermann Researcher 2 (block capitals)	Date	Signature

If you would like a copy of this consent form to keep, please ask the researcher. If you have any complaints or concerns about this research, you can direct these, in writing, to the secretary of the Ethics Committee Faculty Behavioral Sciences of the University of Twente, J. Rademaker (phone: 053-4894591, e-mail: j.rademaker@utwente.nl, Postbus 217, 7500AE Enschede)

Appendix B

Questionnaire

Research Questionnaire – Bachelor thesis

Thank you for participating in this study. This questionnaire consists of four different parts including personal information, a word association test, a sentence completion test, and three self-report questionnaires. The test procedure is going to endure approximately 30 minutes. All collected data is treated anonymously and will not be published. At the beginning of every part, instructions will be presented. Please follow these instructions and maintain the chronological question order.

In case of questions or further interest in the study, please contact us:

Dion Schlesiger: d.h.schlesiger@student.utwente.nl
Janis Sundermann: j.h.sundermann@student.utwente.nl

1. Demographic variables

Age: _____ years

Gender: male / female

Study: _____

2a)

Write the first word you think of next to each word. For example, if the word "doctor" is presented, you might write "nurse". Work as quickly as possible; write the first thing that comes to your mind.

Blanket	
Reading	
Family	
Workout	
Lamp	
Music	
House	
Alarm clock	
Battery	
Handkerchief	
Shopping	
Water	
Energy	
Fruit	
Table	
Television	
Tree	
Exam	
School	
Morning	

2b)

Please complete each of the following incomplete sentences. Like before, write the first thing down that comes to your mind.

a) In the evening _____
b) After a lecture _____
c) A healthy diet _____
d) When I close my eyes _____
e) Drinking alcohol in the weekend _____
f) Homophobia makes me feel _____
g) Working in a group with other students _____
h) I've never been to _____
i) When I lay down _____
j) After dinner _____
k) On the sofa _____
l) When I meet my friends _____
m) Staying out really late _____
n) After a busy day _____
o) Vegetarians are _____
p) I often go _____
q) I like _____
r) My university is _____
s) Learning for my exams _____
t) One of my favorite sports is _____

3. Self-report questionnaire

a) Numeric rating scale

How tired are you right now? Please indicate the intensity of your current state of fatigue by setting a cross on one of the numbers on the presented scale.

Not tired at all

y tired

b) RAND-36

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks…

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Did you feel full of pep?						
Have you been a very nervous person?						
Have you felt so down in the dumps that nothing could cheer you up?						
Have you felt calm and peaceful?						
Did you have a lot of energy?						
Have you felt a lot of energy?						
Did you feel worn out?						
Did you feel tired?						

c) Checklist Individual Strength (CIS20R)

Instruction: In the following you find 20 statements. With these statements we wish to get an impression of how you have felt during the past two weeks. Do not skip any statement and place only one cross for each statement in one of the boxes.

FROM 1 = "No, not at all" **TO** 7 = "Yes, totally"	1	2	3	4	5	6	7
I feel very tired							
I feel very active							
Thinking requires effort							
Physically I feel exhausted							
I feel like doing all kinds of nice things							
I feel fit							
I do quite a lot within a day							
When I am doing something, I can concentrate quite well							
I feel weak							
I don't do much during the day							
I can concentrate well							
I feel rested							
I have trouble concentrating							
Physically I feel I am in a bad condition							
I am full of plans							
I get tired very quickly							
I have a low output							
I feel no desire to do anything							
My thoughts easily wander							
Physically I feel in a good shape							

4.

Please classify your answers on part 2a) and part 2b).

1. If your answer has regard to “fatigue”, please indicate this by setting a “**+**” beside your answer.

OR

2. If your answer has regard to “vitality” please indicate this by setting a “**-**” beside your answer.

OR

3. If your answer does not have any relation with these two terms, please indicate this by setting a “**0**” beside your answer.

Classify your answers on the basis of your **own** subjective interpretation (“what did I mean with my answer?”).

Thank you very much for participating!
In the following you will get further information about the context of this study.