Understanding the Personalisation Process of a Cognitive Bias Modification Training Targeting Fatigue and Improving its Effectiveness - The Personalised IVY Intervention

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Abstract

Background: Cognitive Bias Modification is a treatment technique that targets implicit cognitive processes underlying (mental) health issues by engaging in simple repetitive association tasks. The present study focused on fatigue, aiming at a shift from a self-concept associated with fatigue to a self-concept related to vitality. Participants were asked to use a personalised version of the IVY intervention, which is a CBM training incorporated in a phone application, for three consecutive days. The CBM training included the repeated pairing of vitality-related stimulus words with "self" and fatigue-related stimulus words with "others". Two different personalisation methods were used, namely choosing three stimulus words for fatigue and vitality freely and ranking ten existing stimulus words according to preference. Objective: The present study included two sub-studies. The aim of the first sub-study was to establish the effectiveness of the personalised IVY intervention, whereas the aim of the second sub-study was to explore the participants' perception of the personalisation process as well as their acceptability of the intervention. Methods: In total, 42 participants aged between 19 and 29 completed all required steps, including the pre-test, the three-day-long training (i.e., six sessions) and the post-test. Next to the implicit association task as an implicit measure, participants filled in the VITA-16 and the CIS as explicit measures of vitality and fatigue in both measurement occasions. A linear mixed effect model was used to compare the scores of pre- and post-test. Following the intervention, 20 participants were available for the semi-structured interviews, which were transcribed and coded, and eventually underwent the iterative steps of thematic analysis. Results: It was found that participants' fatigue bias could be corrected into a vitality bias ($d = 0.83$). However, on the explicit level, fatigue symptoms did not decrease and feelings of vitality did not increase significantly. In terms of acceptability, previous findings could be confirmed. The CBM training was seen as easy and straightforward, yet its repetitive nature was considered a drawback. The personalisation led to increased personal relevance and higher feelings of self-efficacy among participants. Difficulties were experienced while finding appropriate and unambiguous stimulus words, clearly related to only one of the two categories. Conclusions: It was suggested to change the explanatory text in the pre-test and implement a demo version before the start of the training. Future research should consider to combine the findings from both sub-studies with the aim to gain a richer understanding of possible factors that strengthen the effectiveness of the intervention or barriers that hinder the intervention to be effective.

Keywords: Cognitive Bias Modification (CBM), Fatigue Bias, Vitality Bias, Acceptability, Personalisation Process, Personalisation Methods, Stimulus Words

Contents

Introduction

Fatigue and Vitality

Fatigue is a commonly reported complaint in primary health care with fatigue being the main or secondary reason for 10 to 20% of consultations with the physician (Maisel et al., 2021). Job and Dalziel (2000) define fatigue as the "state of an organism's muscles, viscera, or central nervous system, in which prior physical activity and/or mental processing, in the absence of sufficient rest, results in insufficient cellular capacity or systemwide energy to maintain the original level of activity and/or processing by using normal resources" (p.469). Fatigue can therefore manifest itself as feelings of tiredness, weakness, being low in energy, or concentration issues (Landmark-Høyvik et al., 2010). In most people, fatigue occurs as a result from exercise, infection, psychological and social stressors, or in relation to lifestyle and situational factors, such as sleep deprivation. In other people, however, fatigue persists over a prolonged period of time due to pre-existing medical or psychiatric conditions, such as cancer, multiple sclerosis, or depression, or as a "medically unexplained" symptom (Jason et al., 2010; Landmark-Høyvik et al., 2010). In this case, fatigue can be considered pathological, because its high intensity and long duration (i.e., more than 6 months) often leads to diminished functional activity and a lower quality of life of the person concerned (Jason et al., 2010). Current literature suggests that a distinction between physical and mental fatigue can be drawn, with physical fatigue manifesting in symptoms such as physical sensations of tiredness, and mental fatigue being connected to cognitive symptoms (De Raaf et al., 2013).

Fatigue is a symptom that is not only experienced by individuals suffering from pre-existing medical or psychiatric conditions, but that is also commonly known in healthy populations, such as employees and University students (Brown & Schutte, 2006; Bültmann et al., 2002). Available research demonstrates that many students experience frequent exhaustion (Frajerman et al., 2019; Klinkenberg et al., 2023). In some students, feelings of emotional and physical fatigue are connected to cognitive slowdown and a sense of decreased capability to cope, also known as student burnout (Olson et al., 2023). Olsen et al. (2023) point out that 25.4% of the students who participated in their study suffer from emotional exhaustion frequently. Research suggests that a diminished sense of well-being and reduced academic attainment can be consequences resulting from fatigue in students (Smith, 2018).

Depending on the duration and the severity of fatigue, a number of different treatment options and fatigue interventions have been proven to be effective with the aim to decrease fatigue. In the case of fatigue persisting in a strong intensity or over a prolonged period of time, research suggests pharmacological treatment or cognitive behaviour therapy (Afari &

Buchwald, 2003; Rosenthal et al., 2008). Afari and Buchwald (2003) further present graded exercise programmes to be effective in reducing fatigue. Considering the approach of positive psychology, mindfulness-based interventions were shown to positively influence attention and self-control in individuals experiencing mental fatigue (Cao et al., 2022). Additionally, mindfulness was found to lead to lower emotional exhaustion and higher engagement in a healthy population of employees, and led to improvements in their sleep quality and fatigue (Michel et al., 2021).

A desirable outcome of fatigue interventions would be to not only reduce fatigue, but also increase feelings of vitality, and thus approach a positive goal. Definitions of vitality are manifold and its conceptualisation differs from study to study (Lavrusheva, 2020). What is certain is that vitality can be considered a positive sense of aliveness and energy, oftentimes connected to enthusiasm and spirit (Ryan & Frederick, 1997). Researchers agree that the experience of vitality is related to physical factors, such as state of health, as well as psychological factors, such as mood or the fulfilment of needs (Lavrusheva, 2020; Ryan & Frederick, 1997). Therefore, vitality can be considered a crucial indicator of personal well-being that fluctuates based on the influence of somatic and psychological factors. Ryan and Frederick (1997) define subjective vitality as an individual's "conscious experience of possessing energy and aliveness" (p. 530). The researchers found that participants reporting better body functioning and physical self-efficacy as well as fewer physical symptoms to possess higher levels of vitality. Moreover, subjective vitality was found to be linked with a sense of agency, self-actualisation, and personal well-being.

Cognitive Biases

Attentional Bias

One possibility to decrease fatigue symptoms while also increasing subjective vitality is to target the underlying cognitive biases influencing fatigue symptoms. The impact of cognitive biases can be direct, meaning that the internal experience of fatigue is altered, or indirect, by making the individual change behaviour with the aim to reduce fatigue (Hughes et al., 2016; Lenaert et al., 2018). Hughes et al. (2016) point towards negative illness beliefs which can be considered beliefs that assign personal meaning to experienced symptoms and influence how fatigue symptoms are interpreted and managed. To illustrate, patients suffering from the chronic fatigue syndrome frequently possess a schema of their illness as being a condition that severely affects them, is uncontrollable and persistent. The researchers stress that negative illness beliefs often result in an increased focus on bodily sensations and the tendency to interpret the experienced symptoms overly negative.

This increased focus on bodily sensations is called selective attention and can also refer to health threat stimuli in the environment (Hughes et al., 2016; Pincus & Morley, 2001). From an associative learning perspective, it is assumed that both exteroceptive as well as interoceptive stimuli are paired with fatigue while it is experienced, leading to an association between fatigue and a particular individual stimulus (Lenaert et al., 2018). Examples for individual stimuli can be certain activities that often or always result in fatigue or a variety of internal signals of the body, such as mild levels of fatigue or feelings of discomfort. By directing attention selectively to bodily sensations connected to higher fatigue levels, the individual concerned tries to increase the predictability of and perceived control over fatigue symptoms. Another aspect of selective attention is the increased vigilance towards health threat stimuli (Hou et al., 2014; Hughes et al., 2016). Hou et al. (2014) stress the importance of an individual's ability to regulate attentional processes in this regard. They found that impaired attentional control is associated with attentional bias towards illness-related information.

Identity Bias

It becomes evident that attentional control is crucially important in the selectivity of "what [individuals] notice, learn, remember, or infer in any situation" (Hou et al., 2014; Markus, 1977, p. 63). Research suggests that this filter is not random, but that it depends on internal cognitive structures enabling a person to process new information in an efficient manner. Efforts to organise, summarise, or interpret one's own actions eventually leads to the development of mental frameworks about oneself, also called self-schemata. Markus (1977) defines self-schemata as "cognitive generalisations about the self, derived from past experience, that organise and guide the processing of the self-related information contained in an individual's social experience" (p. 64). Therefore, self-schemata do not only impact the way an individual perceives the current situation, but also serve as a basis for future judgements, decisions and predictions about the self.

Considering the importance of self-schemata with regard to self-perception, it is valuable to look into the connection between "self" and fatigue. According to Markus (1977), considering a trait adjective as self-descriptive or agreeing with an item on a self-assessment scale can be seen as an indication for an implicit, well-defined self-schema connected to the trait adjective. Transferring this knowledge to individuals who experience fatigue symptoms over a long period of time, it seems likely that they consider the adjective "fatigued" (or related words, such as "tired", "exhausted", etc.) as self-descriptive, possibly pointing to a self-schema of themselves as a "fatigued person".

This thesis is underpinned by the Schema Enmeshment Model of Pain developed by Pincus and Morley (2001). The researchers describe the model to consist of three intersecting schemas, namely the symptom, the illness, and the self. They argue that a "repeated simultaneous activation of elements from different schemas may result in the elements of one being incorporated into another", a process called enmeshment (p. 607). It is stressed that the extent to which the symptom schema becomes linked to the schemas of the illness and the self is from great importance. Individuals suffering from severe fatigue symptoms are considered to be at risk of developing a self-schema of themselves as a fatigued person, likewise, it can be assumed that the exposure of the "self" to vitality-related stimuli has the opposite effect. The "self-as-fatigued-identity" bias is based on the repeated activation of the association between the symptom and the self-schema.

Implicit Association Test to Measure Implicit Cognitive Processes

One possibility to measure the implicit cognitive processes underlying fatigue, is to make use of the Implicit Association Test (IAT). The IAT was found to examine implicit attitudes by measuring their underlying automatic evaluation (Greenwald et al., 1998). In an IAT, participants are usually shown a series of words or images on their screen. These stimuli words are related to two different concepts, such as "Fatigue" and "Vitality" (i.e., target categories). In addition, there is the attribute dimension consisting of two different concepts, such as "Self" and "Other". Participants are repeatedly asked to classify different combinations of target category and attribute dimension by pressing specific keys on their keyboard. The reasoning behind this, is that participants are expected to find one of the combined tasks to be much easier than the other, provided that the target categories are stronger associated with one attribute dimension than the other. The difference in difficulty is assessed by reaction time, which ultimately provides the measure of implicit attitudinal difference between the target categories.

The IAT has been successfully applied in research. In a study conducted on chronic pain, the IAT was used to examine the implicit associations between pain and self, which turned out to be useful in the discovery of dysfunctional cognitive beliefs in individuals suffering from chronic pain (Grumm et al., 2008). This finding is highly relevant for the current study since its focus lies on the "self-as-fatigued-identity" bias and thus, the association between "fatigue" and "self". Grumm et al. (2008) also reports that the IAT was able to differentiate between individuals suffering from chronic pain and participants from the healthy control condition before the start of the treatment.

Cognitive Bias Modification as Intervention Method for Implicit Cognitive Processes

The consequences resulting from cognitive biases in individuals suffering from fatigue can pose large limitations in the daily life of the person affected, therefore, interventions that target the implicit cognitive processes underlying fatigue are needed to change existing thought patterns and, in the long run, alleviate symptoms of fatigue. One technique that is being researched in the domain of eHealth is Cognitive Bias Modification (CBM) which aims to "directly change automatic cognitive processes, such as attention and interpretation" (Jones & Sharpe, 2017, p. 175). CBM comprises the engagement in simple repetitive association tasks that are done a number of times throughout the day with the aim to retrain learnt thought patterns and fundamental beliefs held by the individual about their symptoms (Jones & Sharpe, 2017; Wolbers et al., 2021).

Current literature shows that CBM has been used successfully for a wide range of (mental) health issues, such as anxiety, depression, alcohol and substance use disorders or chronic pain (An et al., 2020; Garfield et al., 2021; Jones & Sharpe, 2017; Manning et al., 2020; Matheson et al., 2019; Vrijsen et al., 2019). In the modification of attentional bis (CBM-A), the overall goal is to redirect the individual's attention to non-threatening cues, whereas in CBM-I (i.e., modification of interpretation bias), the individual is trained to "[interpret] emotional ambiguity in a positive direction" (Bowler et al., 2012, p. 1022). CBM interventions focusing on memory bias aim at reducing biased recall of events, promoting a more balanced way of remembering information from the past (Vrijsen et al., 2019).

Moreover, patients with alcohol or substance use disorders often demonstrate attentional and approach biases towards drug-related cues, which is an automatically activated urge to seek out drugs based on their attributed motivational significance (Garfield et al., 2021). These approach biases can be targeted by a method called approach avoidance task (AAT), where participants repeatedly move a manikin, for instance, towards or away from the respective stimulus using a joystick or keyboard (Field et al., 2008). Other researchers implemented direct swipe movements on a touch screen, either towards or away from the individual's body (Laurens et al., 2020).

In the present study, CBM is used with the goal to modify the "self-as-fatigued-identity" bias. The training focuses on a shift from a self-concept associated with fatigue to a self-concept associated with vitality by asking participants to "repeatedly pair vitality-related words with 'self' and fatigue-related words with 'others'" (Wolbers et al., 2021, p. 2). A correction in perception is then thought to facilitate a realistic interpretation of information and consequently a change of the possibly biased self-concept (i.e., CBM-I). Reaching this goal necessitates the

development of the respective eHealth intervention, a technology "specifically focused on intervening in an existing context by changing behaviour and/or cognitions" (van Gemert-Pijnen et al., 2018, p. 7). In a co-creation process, which included health care professionals, patients suffering from chronic fatigue following their breast cancer treatment, and patient advocates, Wolbers et al. (2021) developed the so-called IVY intervention, incorporating a CBM training in a phone application. The IVY intervention targets the biased self-concept by utilising the repeated classification of stimuli words known from the IAT combined with the method of an AAT.

Personalisation

People using the IVY intervention are required to engage in the CBM training twice a day over a prolonged period of time, bringing attention to questions of acceptability and adherence. According to Sekhon et al. (2017) acceptability can be defined as a "multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experienced cognitive and emotional responses to the intervention" (p. 4). Moreover, patients using eHealth interventions need to do the training continuously as intended by the researchers or developers of the intervention, which is called adherence (Triberti et al., 2018). The researchers stress that an intervention is accepted and used regularly in the long run if the user feels that the eHealth intervention is well adapted to their needs, preferences and routines. Therefore, personalisation might play an important role in increasing the effectiveness of eHealth interventions generally, and the IVY intervention in particular.

Personalisation includes "all aspects of individualising the interaction and information content a system exchanges with its users" (Zanker et al., 2019, p. 160). Personalising eHealth interventions can range from the provision of tailored feedback to the creation of personal avatars or gamification of content (Monzani & Pizzoli, 2020; van Gemert-Pijnen et al., 2018). In the case of the CBM training incorporated in the IVY intervention, the options to personalise the application are still limited. One opportunity to personalise that seems promising with regard to the goal of altering fatigue bias into a vitality bias, is to increase the user's control over the stimulus words they encounter during the training sessions by letting them choose their own stimuli, which was also suggested by Laurens et al. (2020).

Examples of personalised CBM interventions can be found in AAT studies, focusing on alcohol or substance use disorders (Garfield et al., 2021; Manning et al., 2020). In these studies, patients with alcohol or methamphetamine use disorder were trained to avoid drug related images by pushing them away, and to approach non-drug related images by pulling them

towards themselves. The personalisation of these CBM interventions consisted of the individual selection of personally relevant stimulus images, with half of the images being related to the respective drug and the other half of the images being positive non-drug training images representing goals and motivations to stop drinking in a hazardous manner or using substances altogether.

In the study of Garfield et al. (2021), participants were asked to identify the 10 most personally relevant images from a picture selection by rating each image on a computerised visual analogue scale. In the study of Manning et al. (2020) participants chose images from their personal camera roll or from a library of 72 alcohol related images. The researchers also introduced the strategy of "gamification" to personalise the intervention with a scoring system and "bonus points" for fast and correct responses. The display of the highest scoring session was meant to encourage participants to beat their own record. The researchers found that the intervention was accepted by participants, however, in terms of adherence, they reported that fewer than 60% completed all recommended sessions. Overall, the intervention was reported to be effective based on a reduction in standard drinks, drinking days, craving, and severity of dependence.

Considering the benefits of personalisation, such as increased personal relevance, higher commitment and user engagement as well as promising results of previous personalised CBM interventions, it seems to be a reasonable next step to investigate the personalised version of the IVY intervention that targets the "self-as-fatigued-identity" bias using the "push-and-pull" mechanism of an AAT (Manning et al., 2020; Triberti et al., 2018; van Gemert-Pijnen et al., 2018).

The current research is divided into two sub-studies with the first sub-study including the research question related to the first aim of this research, namely to investigate the effectiveness of the personalised IVY intervention by comparing pre- and post-measurements of the IAT. The second sub-study is of qualitative nature and provides answers to research questions two and three. The second aim of this research is to explore participants' acceptability of the intervention. Since a previous usability study conducted by Geerts et al. (2023) investigated the acceptability of a CBM training closely resembling the intervention of the current study, it is examined whether these findings can be confirmed. Thirdly, the current study aims to explore the process of personalisation with an emphasis on the strategies participants used to personalise and their perception of the personalisation process.

Subsequently, the following research question has been posed for sub-study 1:

1. Is the personalised CBM intervention effective in correcting the fatigue bias to a vitality bias in young adults?

And the following research questions have been posed for sub-study 2:

2. To what extent do participants perceive a personalised version of the IVY intervention as acceptable?
3. How do participants perceive the process of personalisation including choosing their own stimulus words and ranking ten existing stimulus words according to their preference, and how does this process impact the user engagement and usability of the IVY intervention?

Regarding the first research question, the following hypothesis was proposed:

1. The personalised CBM intervention is effective in correcting the fatigue bias to a vitality bias corresponding to an increase in negative scores from pre-intervention measurement occasion to post-intervention measurement occasion.

Method

Study Design

The current study consists of two sub-studies. With the first sub-study aimed at establishing the effectiveness of the IVY intervention, the first research question will be answered. The study consisted of a pre-post design with the target group receiving a CBM intervention on three days in a row between the pre- and post-measurement occasion. The second sub-study is related to research questions two and three and included semi-structured interviews to gather insights into the user's acceptability of the personalised intervention as well as the perception of the personalisation process.

Participants

The initial sample of this study included 57 participants, who fulfilled the requirements for participation in the study. The inclusion criteria incorporated a minimum age of 18 years, access to a smartphone and a laptop and proficiency in English. Having pre-existing medical conditions related to fatigue was no exclusion criterion, therefore participants with differing fatigue-levels participated in the study. The convenience sampling method was used to recruit the participants. All students from the BMS faculty of the University of Twente who were registered in an online tool of the university, the SONA system, were able to sign up for the

study and were awarded with one SONA point for their participation. Additionally, known students and friends were asked personally whether they would be interested to sign up for the study. The final sample of the study consisted of 42 participants who met the inclusion criteria and completed all required steps. Among the 42 participants, a gender distribution of 31 females (73.81%) and 11 males (26.19%) with M_{age}= 22.95 and SD_{age}= 2.05 was found. Out of the 42 participants, 23 participants were Dutch, 17 participants were German, one participant was Finnish and one participant was Ukrainian. In total, 20 of the 42 participants (47.62%) were invited to participate in the qualitative part of the study and thus, took part in the follow-up interview. Prior to the start of the study, each participant was provided with a participant information sheet and a consent form including information on the approval of the study by the ethics committee of the University of Twente (see Appendices A and B). The request number of the ethical review by the commission of the BMS Faculty is 240294.

Materials

Online Survey and Implicit Association Task

The online survey included participant information and informed consent as well as demographics. Participants were asked to specify whether they are proficient in the English language. Further, they were required to inform the researchers about pre-existing medical and psychiatric conditions associated with fatigue symptoms with the aim to investigate the possible impact on the manifestation of fatigue bias (Compañ et al., 2011; Hughes et al., 2016). Additionally, participants were instructed to indicate the ease with which they can use various functions of a mobile device since it has been shown that previous exposure to technology possibly influences the effectiveness of an online intervention due to increased commitment and engagement (Carey et al., 2008; Geerts et al., 2023).

Digital Literacy. The pre-test survey included the MDPQ-16, which is a shortened version of the MDPQ (Roque & Boot, 2018). This test was originally developed for the older population but has also been found to be a reliable and valid measure of mobile device proficiency for younger adults (Cronbach's a = 0.96, with subscales ranging from 0.75 to 0.99). Questions in the MDPQ-16 ask participants to indicate how well they can perform certain actions on a mobile device, on a 5-point Likert scale ranging from "never tried" to "very easily". The MDPQ-16 consists of 8 subscales, namely "mobile device basics", "communication", "data and file storage", "internet", "calendar", "entertainment", "privacy", and "troubleshooting and software management", with each subscale containing 2 items. In the current study, Cronbach's α was 0.75.

Self-Reported Fatigue. The Checklist Individual Strength (CIS) is a multidimensional questionnaire that consists of 20 items assessing feelings of fatigue during the past week on a 7-point Likert scale, ranging from "yes, that is true" to "no, that is not true" (Beurskens et al., 2000). The CIS consists of four subscales, namely subjective feeling of fatigue (e.g., "I feel tired"), concentration (e.g., "Thinking requires effort"), motivation (e.g., "I feel like doing all kinds of nice things") and physical activity (e.g., "I do quite a lot within a day"). The CIS was validated among the working population and has shown to be a good predictor of chronic fatigue. According to Beurskens et al. (2000), the CIS appears to be reliable with Cronbach's α for the total scale being .90. In the current study, Cronbach's α was 0.95 for the total scale.

Self-Reported Vitality. The VITA-16 is a 16-item questionnaire assessing the vitality level among adults during the past month (Strijk et al., 2015). Answer options range from "seldom" to "always", which can be indicated on a 7-point Likert scale. The VITA-16 consists of three core dimensions, namely "Energy", "Motivation" and "Resilience". The energy dimension reflects feelings of energy (e.g., "My battery is 100% charged at the start of the day."). The motivation dimension is characterised by the motivation to set and achieve goals (e.g., "When I have a goal, I immediately make plans to achieve this goal."). The resilience dimension is about the ability to cope with daily life problems and challenges (e.g., "I can very well find solutions in difficult situations"). The VITA-16 appears to be reliable (Cronbach's α: 0.89 – 0.95) and has shown good validity among the Dutch adult population. In the current study Cronbach's α for the total scale was 0.94.

Implicit Association Task. Incorporated in the survey was also the central task, namely the IAT (Greenwald et al., 1998). Participants were asked to place their middle or index finger on the E and I key of their keyboard and press either of the keys according to the category of the stimulus word in the middle of the screen. The IAT consisted of seven blocks in total (see Table 1), which were made up of different combinations of "self/other" and "fatigue/vitality" pairings. The average response latency per block as well as the number of wrong and valid assignments of words was measured and presented as an overall D-score. Split-half reliability was found to be 0.75 for the pre-test and 0.73 for the post-test.

Table 1

Blocks in the IAT

Block	Left	Right	Function	Trials
1	Self	Others	Exercise	20
2	Vitality	Fatigue	Exercise	20
3	Self + vitality	Others + fatigue	Exercise	20
4	Self + vitality	Others + fatigue	Test	40
5	Others	Self	Exercise	20
6	Others + vitality	Self + fatigue	Exercise	20
7	Others + vitality	Self + fatigue	Test	40

Personalisation. In a final section of the survey, participants were asked to rank the standard fatigue- and vitality-related stimulus words according to their preference from 1 to 10, with one indicating that the word was seen as extremely representative of the participant's personal perception of fatigue or vitality and ten indicating that the word was least representative. In addition, participants were asked to provide three personalised stimulus words they associate with fatigue and three personalised stimulus words they associate with vitality. Participants were prompted to think about activities that evoke feelings of fatigue or vitality and asked to remember four set criteria to be met by the chosen stimulus. These criteria included that the stimulus had to be a single word, which was not to be found on the existing list of stimuli (see Table 2). Further, the stimulus needed to be clear and explicit as well as personally relevant for the individual choosing the words.

Table 2

Existing list of stimulus words

Vitality	Fatigue
Energetic	Exhausted
Fit	Spiritless
Lively	Weak
Awake	Slow
Active	Dull
Strong	Sleepy
Vital	Fatigued
Fast	Lifeless
Powerful	Powerless
Attentive	Tired

Post-Test Survey. At the end of the post-test survey, participants were eventually asked about their experience with the IVY intervention and the possibility to personalise their IVY training. They were asked how many training sessions out of the total of six training sessions they completed. Participants were required to indicate their smartphone model to detect possible differences in how well the IVY intervention works on different phones and operating systems. In addition, they were given some questions (e.g., "How important do you consider the option to personalise?") and statements (e.g., "In my perspective, personalisation of training words gave me extra motivation to keep training.") which they had to evaluate based on a 7-point Likert scale.

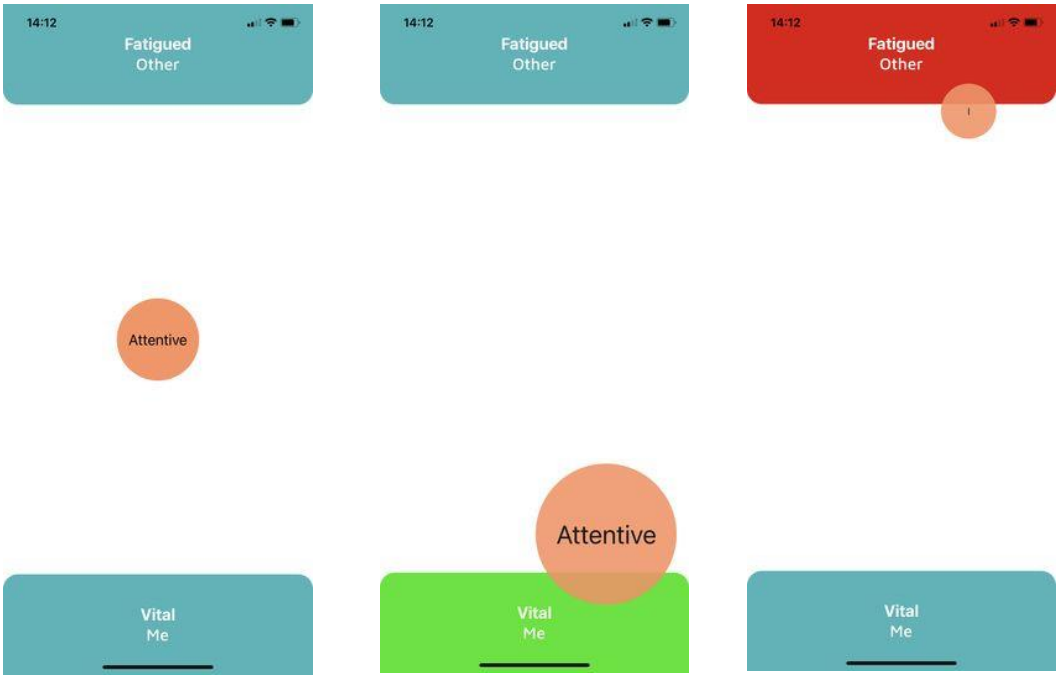
E-Health Intervention IVY

The E-Health Intervention IVY is part of the Twente Intervention and Interaction Machine (TIIM), which has been developed by the BMS Lab of the University of Twente. Participants who opened the TIIM App found themselves on the start page showing their personalised IVY intervention. Clicking on the intervention opens a new page which contains the active and completed training sessions as well as a "Welcome" page and a module for frequently asked questions. Participants received notifications when new training sessions became available, at 8 am and 4 pm each day. They could then click on the respective module and start their training. During the practice, participants were instructed to swipe the stimulus

word appearing in the middle of the screen either towards the "Vital" and "Me" category or the "Fatigued" and "Other" category. Depending on whether the stimulus word is swiped to the right or wrong category, the respective category turns green, meaning "right", or red, meaning "wrong" (see Figure 1). The immediate feedback based on the colours is supplemented by the sound of a bell indicating success or an unpleasant sound suggesting that the participant failed to choose the right category.

Figure 1

Phone Screen of the IVY Intervention During a Training Session



Interview Scheme

The interview scheme served as a basis for the follow-up interviews held online (see Appendix E). A list of possible probes for the interviewer was provided. The interview consisted of 18 questions in total and started with some open questions (e.g., "What are your thoughts about the IVY intervention, now that you have experienced it?") with the aim to find out what participants came up with first and whether they mentioned the aspect of personalisation on their own initiative. The interview also included questions on the process of personalisation (e.g., "I saw you chose stimuli words x, y, z for fatigue. How did you come up with these stimuli words?"). Further, questions about the user's acceptability (e.g., "Are there any aspects of the personalised IVY intervention that you felt could be improved or enhanced to better meet your needs?") were posed.

The interviews took place on the web conferencing platform zoom (version 5.17.11) and were recorded via the platform. In a second step, the interviews were transcribed with the transcription software Amberscript. The interviews were analysed using ATLAS.ti (version 24.1.0.30612), facilitating the coding process.

Procedure

Participation in the current study was firstly comprised of an online survey including the IAT that served as pre- and post-measure for the CBM training. Participants who signed up via SONA or accessed the survey directly via the respective link were informed about the procedure and all steps included in the study. They were strongly urged to answer the survey on a laptop or computer due to the IAT which requires a keyboard. After participants were provided with participant information and the option for informed consent, the survey could be started. Participants began with answering questions about demographics, English proficiency, technology use and pre-existing medical conditions. Afterwards, participants filled in the CIS and VITA-16, and subsequently took part in the IAT. Each participant was required to personalise the stimulus words to be used in the training. Before the first survey came to an end, participants had to create their personal code for identification purposes and indicate their email address for follow-up instructions regarding the IVY training and the post-test survey. The pre-test survey took approximately 20 minutes.

With the end of the pre-test survey, participants were sent an email with further instructions regarding the IVY intervention in the TIIM app, including links to the App Store and Google Play Store. During the registration process, participants were asked to fill in their personal code instead of their first and last name to ensure that the personalised information from the survey could be matched with the right TIIM account and to safeguard participants' confidentiality. Participants were required to log in and search for the study by using a numerical code specified for the current study. After the registration process on the side of the participants was concluded, the researchers created a personalised IVY intervention for each participant which was based on the personal stimulus words and the ranking of standard stimulus words (see Appendix C). Participants received a notification when their personalised training sessions were available, so that they could start with their own IVY intervention. Overall, the participants were expected to engage in a total of six training sessions over the course of three days. Since each training session lasted 5 minutes approximately, the expenditure of time amounted 30 minutes in total.

With the completion of training sessions, participants were sent an invitation email to participate in the post-test survey similar to the first one. The post-test survey again consisted

of the CIS and the VITA-16 as well as another IAT. In addition, participants were instructed to evaluate their individual process of personalisation and their satisfaction with the IVY intervention. Participants were asked for their personal code once again. The post-test survey took approximately 15 minutes.

After the participants took part in the post-test survey, they were invited for a follow-up interview that was conducted online and took between 15 and 20 minutes. The participants were sent participant information and informed consent via email before the interview was held and were asked to send back the signed form (see Appendix D). The interviews were conducted in either English or German depending on each participant's preference. Before the recording was started, participants were informed about the aim and procedure of the interview and were asked for verbal consent. The interview included questions about the process of personalisation as well as user's acceptability of the IVY intervention in the TIIM app (see Appendix E).

Data Analysis

Quantitative Analysis

To evaluate the impact of the IVY intervention on altering fatigue bias towards vitality bias, participants' IAT scores at the pre- and post-measurement occasion were compared by using a linear mixed effect model. While the independent variable was the three-day long personalised IVY training each participant received, the dependent variable was the participants' fatigue/vitality bias. For the respective analysis, the IAT scores were provided as D-values, which were automatically calculated by the survey programme SoSci, following the regulations set out by Greenwald et al. (2003). These D-values constitute an index value for the strength of the association measured by the IAT. D-values are continuous and predominantly occur within a range between -2 and +2. In this case, a more positive D-value indicates a fatigue bias (stronger association between self and fatigue, or between others and vitality), whereas a more negative D-value demonstrates a vitality bias (stronger association between self and vitality, or between others and fatigue). Thus, an increase in negative scores constitutes the desired outcome (i.e., stronger vitality bias) in this case.

The formula for the linear fixed effect model is shown below, with the "post" variable (D-value after the IVY training) as dependent variable. Here, "b_0" indicates the D-value before training, and "b_1" shows by how much the cognitive bias changes from pre- to post-test.

$$post = b_0 + id + b_1 * pre$$

The linear fixed effect model includes the random factor "participant" to account for the variance between patient scores. The variable "measurement occasion" is the fixed factor. The

intercept can be interpreted as the average level of cognitive bias before the training, whereas the dummy variable "dummy_postIAT" represents the direction and magnitude of the training effect. Thus, if the t-value of "dummy_postIAT" is found to be statistically significant (< 0.05), and if the D-value changes into or increases in a negative direction (towards a vitality bias) from pre- to post-measurement occasion, then it can be concluded that the personalised IVY intervention has an impact on modifying fatigue bias to vitality bias. The R-package "lme4" was used to fit the model and the R-package "lmerTest" was used to perform hypothesis testing.

Descriptive analyses, such as determining measures of central tendency and dispersion as well as their graphical representation were carried out. Moreover, the parametric assumptions of dependency, normality of residuals and homogeneity of variance were tested with the aim to come to a conclusion of whether a linear mixed model or a non-parametric alternative, in this case Wilcoxon's test, was used.

To further investigate the impact of the IVY intervention on self-reported fatigue and vitality, the difference in CIS- and VITA-16-scores were compared between pre- and post-test as well. Here, a significant effect of the IVY training would reflect an improvement of vitality or fatigue symptoms. Since this is again a repeated measure filled out twice by each participant, the same procedure of analyses was applied to investigate the effect of the IVY training on vitality and fatigue.

Qualitative Analysis

With the aim to gather insights into participants' acceptability of the IVY intervention as well as their individual personalisation process, a phenomenological approach was used to analyse the data. Initially, interviews were transcribed orthographically using Amberscript. Afterwards, each transcript was checked for correctness by listening back to the recordings to compare written and spoken words. The finished transcripts served as a basis of the data to be analysed using thematic analysis, which is a "method for identifying, analysing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79). A deductive approach was used since the interview scheme was constructed on the basis of prior determined research questions. Initial codes closely resembled the structure of the interview scheme. Yet, the research was highly explorative in nature as themes in relation to the personalisation process emerged from the given data without trying to fit preconceived notions.

According to Braun and Clarke (2006) thematic analysis consists of six steps, which were followed in the current study. In the first step, transcripts were read to become familiar with the existing data. Next, initial codes were generated that included meaningful features of the data. Within the newly developed codes, it was searched for broader themes summarising

groups of codes. In a fourth step, these themes were reviewed and codes were restructured. These two steps were found to be an iterative process since codes were narrowed down step-by-step by alternating between the step of classifying codes into broader themes and reviewing them. Eventually, superordinate codes as well as subordinate codes were defined and received their label. The number of quotes elicited per category was documented and later put into the report, together with a short code description and meaningful quotes.

Results

Effectiveness

With the aim to investigate the effectiveness of the personalised IVY intervention in correcting fatigue bias to a vitality bias, descriptive statistics were derived in a first step. These included minimum, maximum, median, mean scores and standard deviation obtained in the pre- and post-test of the IAT, the VITA-16 and the CIS (see Table 3). Further, the mean difference between pre- and post-measurement occasion was identified.

Table 3

Table Showing Descriptive Statistics Obtained in the Pre- and Post-Test of the IAT, VITA-16 and CIS as well as the Mean Difference between Pre- and Post-Measurement Occasion

Measure	Pre-Test					Post-Test					Difference	
	Min	Max	Median	*M*	*SD*	Min	Max	Median	*M*	*SD*	*M*	*SD*
IAT	-1.06	1.06	-.24	-.23	.42	-1.19	.41	-.59	-.56	.37	-.33	.50
VITA-16	2.88	6.42	4.69	4.62	.86	2.4	6.56	4.76	4.66	1.03	.04	.87
CIS	30	126	73	71.48	21.62	32	120	67.5	69.4	20.53	-2.07	18.34

In a second step, the linear mixed effect model was used with the aim to investigate, whether a significant change from pre- to post-test on implicit as well as explicit measures of fatigue and vitality could be found. The parametric assumptions of dependency, normality of residuals and homogeneity of variance were checked with the aim to determine whether the linear mixed effect model was the suitable analysis to be chosen or whether a non-parametric alternative, that is Wilcoxon's signed rank test, would be used based on the premise that assumptions were violated.

It was decided to run all three analyses twice, once including outliers and a second time excluding outliers to identify whether outliers caused significant distortions during data analysis. The full dataset consisted of 42 participants, which was reduced to 36 after taking out outliers (IAT: scores < 0.6; VITA-16: scores > 2.9; CIS: scores < 115). The findings of the sensitivity analysis can be found in Appendix F.

In the case of the IAT, the parametric assumptions of normality and homogeneity of variance were met, so that a linear mixed effect model was the chosen analysis (see Appendix G). Running the linear mixed effect model, a significant change of IAT scores from pre-test to post-test was found, indicating a beneficial training effect from fatigue bias to vitality bias (b = -.33, $t(42) = -4.32$, $p < 0.001$, $d = .83$). The null hypothesis can be rejected.

In case of the VITA-16, the assumption of normality was met, while the assumption of homogeneity of variance was violated, meaning that Wilcoxon's test was run (see Appendix G). The Wilcoxon signed-rank test indicated that there was no significant difference between pre-test and post-test with regards to the VITA-16 scores, $V = 532$, $p = .32$. Therefore, the null hypothesis cannot be rejected. The difference scores between pre- and post-measurement occasion were positive with a mean difference of .04, indicating a minimal tendency for the VITA-16 scores to increase on average.

In case of the CIS, both the assumption of normality as well as the assumption of homogeneity of variance was violated (see Appendix G). The Wilcoxon signed-rank test indicated that there was no significant difference between pre-test and post-test with regards to the CIS scores, $V = 325$, $p = .26$, therefore the null hypothesis cannot be rejected. The difference scores between pre- and post-measurement occasion were negative with a mean difference of -2.07, indicating a tendency for the CIS scores to decrease from pre- to post-test on average.

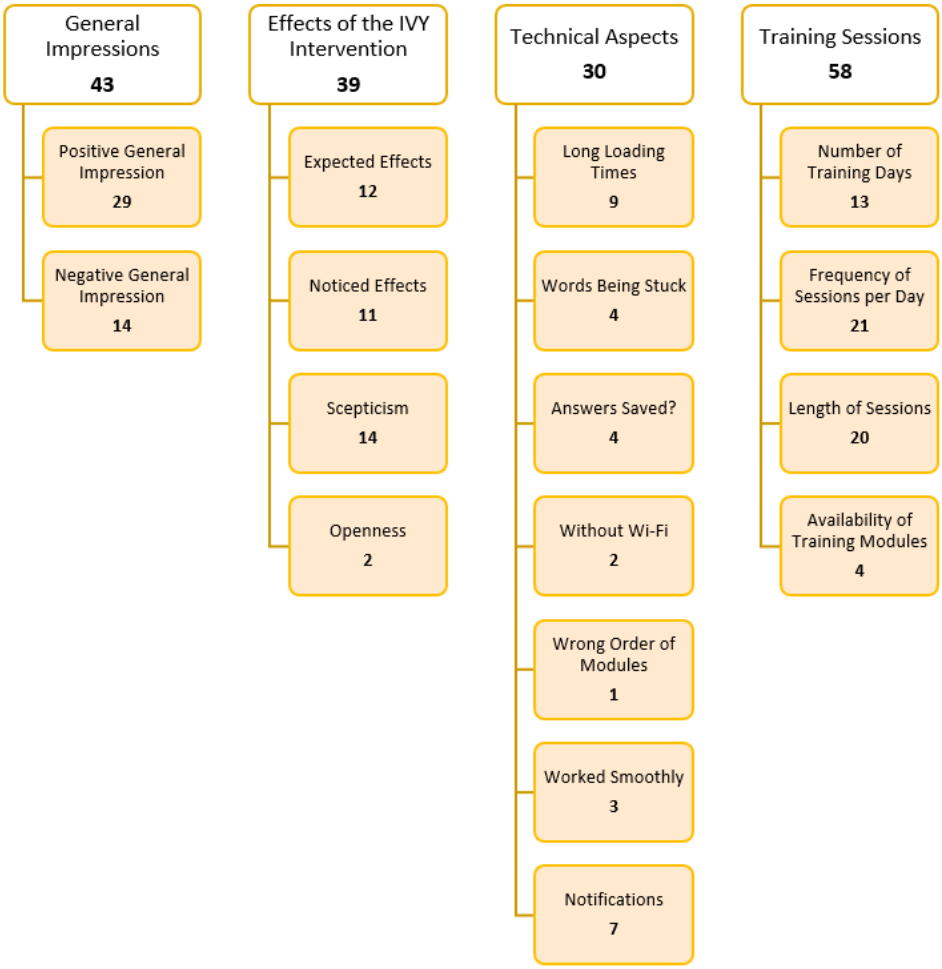
Acceptability

With the aim to explore the participants' perception of the personalised IVY intervention regarding the personalisation process as well as the user's acceptability, twenty interviews were transcribed and coded in a first step. Categories that emerged out of patterns which became visible in the participants' answers were summarised under ten superordinate codes, eliciting 380 quotes in total. If one quote fitted into more than one category, it was coded as many times as codes applied, meaning that the categories are not fully distinctive. Under the general term "Acceptability", 170 quotes were classified into the following codes, namely "General Impressions", "Effects of the IVY intervention", "Technical Aspects", and "Training Sessions" (see Figure 2).

The following section summarises the most noteworthy findings with regards to the acceptability of the IVY intervention. Since the main focus was put on the perception of the personalisation process, findings on the acceptability of the intervention are not displayed as extensively in the main text. For a full overview of codes, example quotes of the categories and comprehensive results on the acceptability of the personalised IVY intervention, please refer to Appendix H.

Figure 2

Overview of Superordinate Codes "Acceptability" including Subordinate Codes and Their Frequency



General Impressions

Overall, 70.73% of the quotes within the code "General Impressions" belong to the subordinate code "Positive General Impression", whereas 29.27% of the quotes belong to the code "Negative General Impression". The application was described to be intuitive and user-friendly, so that users can be expected to engage in the training independently. Most participants

perceived the CBM training as straightforward and easy to use. The game character of the intervention, the fact that the training could be done at any time and in any place, and the option to personalise were points that were appreciated by participants. The biggest drawback of the IVY intervention was the repetitive nature of the CBM training, which was perceived as boring due to the lack of interaction and intellectual challenge.

Effects of the IVY Intervention

Participants expected to improve their scores on the post-test survey, experience small changes in their daily life, such as feeling more energised during the day, and thought that the IVY intervention could be beneficial to improve one's self-image. Most participants expected that unconscious processes would be altered. Noticed effects included an increased focus on vitality-related words and subjective improvements in categorising words correctly and fast. Some participants reported to doubt the effectiveness of the intervention based on the short time span, but also because they could not think of a reason why they would use the application. Another reason for the participants' scepticism was the lack of visibility of clear results and progress, which differentiates the IVY intervention from those that use a change of behaviour or cognition to target specific problems. The rationale behind the intervention was not clear enough.

Technical Aspects

In terms of technical aspects related to the TIIM application, 40% of the participants in the interview sample did not experience any technical difficulties and perceived the application to work smoothly and without major problems or complications. On the contrary, 60% of the participants in the interview sample had technical difficulties at least once during the timeframe of the intervention. These difficulties were long loading times, words being stuck on the screen, unclarity, whether answers had been saved, the intervention not working without Wi-Fi, and a wrong order of modules. The proper functioning of the TIIM application was found to be from great importance for participants' overall satisfaction with the CBM training. All participants agreed that notifications about the availability of new training sessions were useful and important, so that their implementation can be regarded as valuable.

Training Sessions

Concerning the scope of the IVY intervention, participants reported that they considered the number of three days as too short for the intervention and expressed the wish to continue the training over a longer period of time. Two sessions per day were perceived as a good

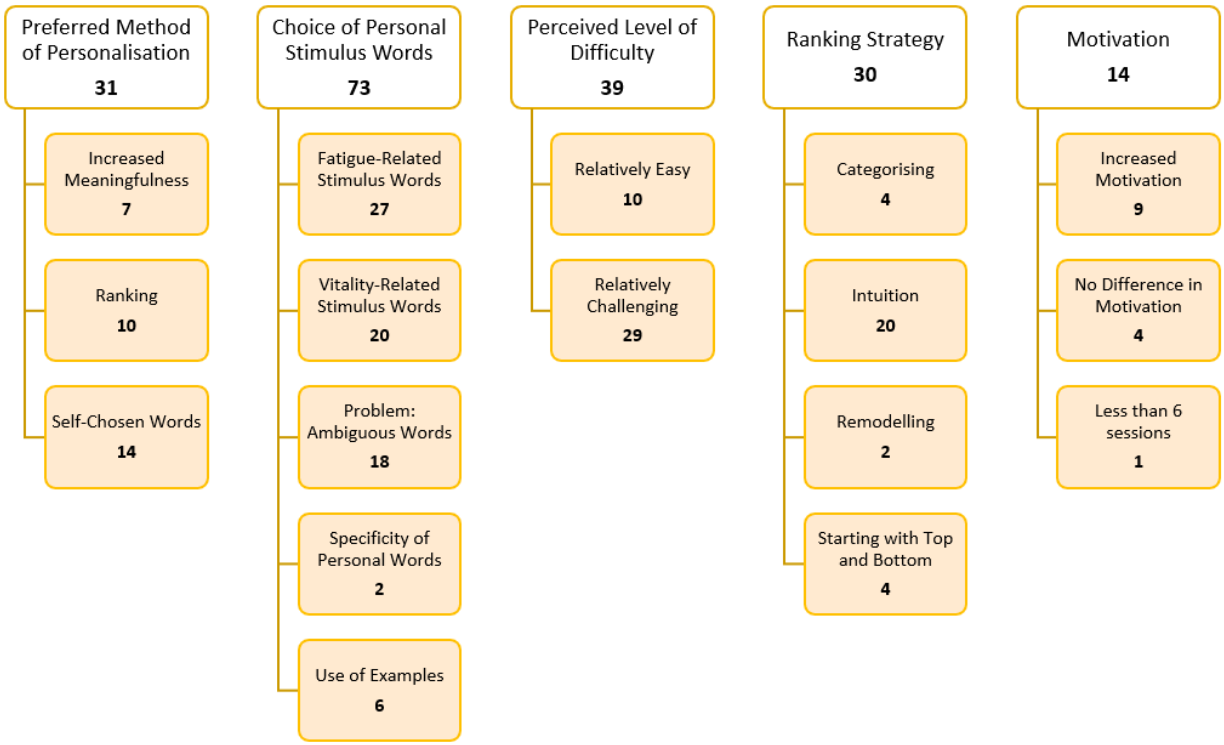
frequency of sessions, yet a sizeable minority was less satisfied with this frequency, with a balance between those preferring more daily sessions and those preferring fewer daily sessions. Regarding the length of each session, participants disagreed since one half perceived the session length as too long, whereas the other half considered it appropriate. It can be considered beneficial to adjust the times of availability, so that participants are able to start the training earlier than 8 am.

Process of Personalisation

The broader term "Personalisation Process" elicited 187 quotes in total that were put into the categories "Preferred Method of Personalisation", "Choice of Personal Stimulus Words", "Perceived Level of Difficulty", "Ranking Strategy" and "Motivation" (see Figure 3).

Figure 3

Overview of Superordinate Codes "Personalisation" including Subordinate Codes and Their Frequency



Preferred Method of Personalisation

This code provides a summary of participants' opinions on the two different methods of personalising the IVY intervention. The first way to personalise was to freely choose three words that participants personally associated with fatigue or vitality. The second way to personalise was to rank the already existing stimulus words from one to ten according to

individual preference. The ranked words were adjusted in frequency, so that participants encountered their preferred words more often in the training than their less preferred words. 22.58% of the quotes elicited in the category "Preferred Method of Personalisation" did not relate to either of the two methods, but included general advantages of the personalised IVY intervention (see Table 4). These advantages can be put into two main categories, namely, an increased meaningfulness due to a personal connection to the training and higher feelings of self-efficacy based on the possibility to exert control over the stimulus words. 32.26% of the quotes elicited can be linked to the method of ranking. Participants appreciated that the method was straightforward and provided a lot of guidance, however, a personal connection to the existing words was not always given. 45.16% of the quotes elicited can be linked to the method of choosing the stimulus words freely. This method offered the advantage that the intervention felt personal and connected to the participants' daily life and feelings, however, it was often perceived as more difficult.

Table 4

Reasons Why Participants Preferred One Method of Personalisation

Preferred Method of Personalisation	Example Quote	Frequency
General Advantages of Personalisation		n = 7
Increased meaningfulness due to personal connection	"Well, I would definitely always prefer the personalised version, because it is somehow more personal and directly connected, and it somehow has more to do with one's own life than a standardised version." (Translated from German, participant 1, female, 26)	n = 5
Self-efficacy	"It's more that you kind of have your share in it as well. That you can decide a bit of how you want how you want it." (Participant 9, male, 22)	n = 2
Self-Chosen Words		n = 14
Personal relevance	"I mean, the ranking is also personalization in a way, but actually giving your own input and being able to connect it with your own emotions or experiences has a much deeper personalization effect to me. So, and it's a bit creative and I like creative stuff." (Participant 20, female, 23)	n = 10
	"Because you have chosen them based on your own experiences and on your own preferences. And yes, also the ranking is for sure on your preferences, but with words	

	who were already given. So, some were not super fitting, I would say. Or not. Not maybe fitting is the wrong word, but not. I would not. They're belonging to the word fatigue, but not to my fatigue." (Participant 18, female, 24)	
Higher motivation	"If I have had only the standardised words, would not have had the motivation to do it permanently. So, the personalised words have contributed a very, very large part to this." (Translated from German, participant 1, female, 26)	n = 3
Ranking		n = 10
Easy and straightforward	"Ranking the words was a bit more easy because I could. Like there were existing words and I just had to choose like a ranking order." (Participant 13, female, 22)	n = 2
Adjusted frequency of stimulus words	"I think I prefer the [new] version because it feels a bit more because of some of the words. I felt like they did not relate at all with me, and then they were less frequent on the app, and I think that's better." (Participant 14, female, 21)	n = 4
Satisfaction with already existing words	"And I could also already associate myself with the words quite well, which you provided. So that's why I had no problems with ranking them, because I was like, yeah, that would be vitality for me as well." (Participant 19, female, 22)	n = 2
Minimises problems related to the self-chosen words, such as choosing ambiguous stimulus words, regretting one's choice of words, choosing words that do not match existing ones	"I prefer the ranking, because it just already gave you a structure of good fitting words, um, that really fit into the categories. And all you did was ranking them. So, I'd say you couldn't really do anything wrong. And yeah, when choosing the words um, especially before having like. Yeah, I guess that's why I like the ranking mode, because, uh, I don't really like, uh, my choice of words in the end." (Participant 4, male, 21)	n = 2

Choice of Personal Stimulus Words

The choice for both, fatigue- and vitality-related stimulus words was often based on situations in which participants repeatedly felt fatigued or that caused them to feel fatigued afterwards. Further, participants were influenced by present conditions, such as being sick or taking many exams. A number of participants chose opposite words for fatigue- and vitality-related stimulus words. Overall, 104 different words were chosen for fatigue and 84 different

words were chosen for vitality. Especially among the fatigue-related stimulus words, a high number of ambiguous words could be identified. In the context of this study, ambiguous words were those that did not clearly belong to either of the two categories (i.e., fatigue or vitality). The choice of words was often very context-dependent, qualifying a word for both categories depending on a participant's state of mind or external circumstances. Ambiguity of words was often noticed in the training when a word that was anticipated to belong to fatigue, for instance, was categorised wrongly.

Fatigue-Related Stimulus Words. One strategy that participants used to come up with their own personal stimulus words was to ask themselves, what they would do or how they would feel when they are fatigued (n = 4) which was also done by participant 19 (female, 22) who said "I was thinking about like when I would feel fatigued, like, what would I do? How would I feel?". Many participants imagined situations where they felt fatigued and then reflected what they usually do (e.g., stop talking) or how they feel (e.g., lonely) and based their personal stimulus words on these situations and the feelings associated with it. Other participants tried to think about situations that cause them to feel fatigued and leave them drained afterwards (n = 8).

Generally, it was noticed that participants created association chains by thinking what one would connect with fatigue, with some participants mentioning specific examples (n = 5). Stress, loneliness, mind wandering, concentration problems, being lazy or unproductive, feeling uncomfortable or burnt out were themes that were found to be closely connected to fatigue. It was also mentioned by some participants that their choice of personal stimulus words was dependent on how they felt in the present moment (n = 5). Sometimes, their word choice was influenced by feelings or events on that day or in the past week. One participant, for example, described that they had just recovered from a disease which caused them to feel fatigued, so that they chose "Disease" as a stimulus word. Another participant described it the following way:

> It was like I had a bad day. Nothing worked. And then I was like, oh. Life is exhausting. Oh, waking up is also exhausting. Even starting the day is exhausting. Um, and studying is exhausting. And this is a big part of me now. So, I was like, oh, I don't like it. (Participant 12, female, 26)

Another strategy was to come up with words being the opposite of vitality (n = 5). Many participants described that they simply looked at their vitality-related stimulus words, they were asked to come up with first, and then turned these words into their fatigue-related stimulus

words.

Overall, participants chose 104 different stimulus words, of which 11 were German words and 8 were Dutch words (see Appendix I). The word category with the highest number of words consisted of nouns related to or causing fatigue, such as “Disease”, “Loneliness” or “Stress” (n = 39). A large proportion of participants also chose adjectives describing their personal fatigue, such as “drained” or “unmotivated” (n = 27). Participants also chose 17 different verbs, which could be identified as causes of tiredness or fatigue (e.g., “overworking”, “arguing”). Some words, such as “raining” or “dark” could not be classified into the mentioned categories. Considering the aim to modify fatigue bias towards a vitality bias, there were some words that are considered poor choices from the viewpoint of the researchers of this study. These words can either clearly be categorised to vitality (e.g., “Life”, “Energy”) or bear some ambiguity that could pose difficulties during the CBM training (e.g., “Partying”, “Socialising”).

Vitality-Related Stimulus Words. The vitality words were mostly chosen according to the same principles as the fatigue-related stimulus words. Participants described that they often thought of situations in which they feel energised and lively or situations that cause them to feel vital in the present moment or after doing certain activities (n = 9).

> I thought about. Like what gives me energy and what makes me feel positive or like when I'm leaving a certain kind of situation what is the reason why I feel better? I don't know, because, for example, if I help someone, I get like a really positive feeling. Also, with being creative, like if I do something creative, I feel like really, really good. And uh, with socializing, it's like normally I also feel good. (Participant 13, female, 22)

Words that often appeared in the interviews, which were not chosen, but still connected to vitality in a meaningful way for many participants, were for instance, being satisfied or productive, having fun, achieving a goal, taking risks, being outside, being engaged, “gezellig”, or doing well (n = 8). Also, the present moment influenced the choice of words. One participant explained “…and it was sunny. So, this also increases my mood a lot. So, I also chose that.” (Participant 18, female, 24), while another chose the word “Boyfriend”, because they were visiting (n = 2).

One strategy that stood out was that participants formulated ideals as their vitality-related stimulus words (n = 3). When explaining why they chose their words, the participants used phrases such as “If somebody is like in good vitality” or “You have to be”, which sounds a bit detached, as if they were thinking about vitality as something that is only accessible to certain people under certain circumstances and not necessarily connected to themselves.

> And functioning I would say vital people are like well-functioning in what they're doing and their jobs. They, um, don't struggle or don't like in ideal. In an ideal scenario, they don't struggle with like keeping up with day-to-day tasks. (Participant 14, female, 21)

Overall, participants chose 84 different stimulus words that can be classified into different categories (see Appendix I). Out of the total number of words, 9 were German words and 10 were Dutch words. The majority of words were nouns (n = 23), such as “Inspiration”, “Purpose”, “Friends” or “Holiday”. In addition, 17 nouns were related to different sports, with “Running” and “Volleyball” being the words chosen most often. Moreover, 15 different adjectives describing feelings of vitality (e.g., “resilient”, “happy”) could be counted. A smaller proportion of participants also chose verbs associated with vitality, such as “singing” or “laughing” (n = 10). Generally, words related to sports, friends or holiday were chosen most often by participants.

Problem: Ambiguous Words. One of the main issues that participants mentioned during the interviews was that they chose words that were ambiguous, and thus, did not clearly belong to only either of the two categories. Participants explained that their words often led to confusion in the training, because they had ambivalent feelings about their chosen word and thus, did not know which category applied (n = 11).

> Um, for the other two, um, it was, quite strange because, um, partying can or often like leaves me unproductive and tired on the next day. But at the same time, I, um, associate also positive things with it. And so it happened that I think a lot of times also with responsibility. Um, I moved them towards me as a positive thing because partying and also responsibility can or are positive things to me, but they also leave me tired at some point. So, um, I wasn't quite, um. I didn't really like my choice of words in the end. (Participant 4, male, 21)

The words that were chosen, but considered a poor choice after the training were, for instance, “partying”, “responsibility”, “getting up”, “life”, “studying”, “socialising”, “fighting”, “videos”, or “talking”. One participant also made a remark about the choice of the word “outside”, which was considered ambiguous by them based on the literal meaning of the word in combination with the hand movement (i.e., swiping) that was part of the intervention (n = 1). They explained that they were tempted to push the word upwards, since this is the movement, one would connect with “outside”, while the word actually belonged to the vitality category for the participant. Concerning the ten existing words, participants pointed out that powerful and powerless were often confused due to their similarity and that some of the words, such as “fit” could be interpreted in different ways (n = 3).

It was mentioned that choosing the stimulus words as well as how well one did on the training was perceived as mood dependent (n = 3). One participant explained that the training was more challenging after they came back from a run, since they felt exhausted but did not interpret the exhaustion in a negative way at all.

Specificity of Personal Words. In two interviews, a conversation around the specificity of the chosen words emerged (n = 2). Generally, only one participant chose the word "Lotta", the name of their dog, as a vitality-related stimulus word. All other words were less specific and did not include names or other personal references. Two participants explained why they chose more general terms, in this case "boyfriend" and "travelling", instead of their boyfriend's name or a specific country. They said that they felt the more specific words not to fit in with the already existing words. Further, they did not seem to be aware of the possibility to choose such specific stimulus words.

Use of Examples. In the survey where participants were asked to indicate their personal stimulus words, a description of how to come up with the words, including criteria that needed to be met, were provided. Additionally, an example and the ten existing stimulus words were listed to avoid that participants would choose words already on the list. Overall, participants appreciated that an example was given and reported that they would add an example for the fatigue-related stimulus words as well (n = 6).

Perceived Level of Difficulty

This code entails the reasons why participants perceived the task to come up with three personal stimulus words as relatively easy or relatively challenging. The code "Relatively Easy" elicited 25.64% of the quotes among participants from the interview sample, while the code "Relatively Challenging" elicited 74.36% of the quotes. The two main challenges in finding one's stimulus words were thinking effort and satisfaction with the words already existing. One recommendation for future CBM interventions of this kind could be to offer the intervention in the participants' mother tongue to make it easier.

Relatively Easy. Participants often said that it was not too difficult and definitely doable to find their personal stimulus words. Many participants came to the conclusion that the choice was relatively easy based on the short time they spent on creating their personal stimulus words, saying things like "It took me not that long to come up with it" or "I think they popped up immediately" (n = 7). Generally, it seems that the participants who perceived the task as relatively easy, did not seem to overthink their choice too much, but often chose the first words that came to mind. Other participants had clear strategies helping them to come up with the

word, which is why they perceived the task as easy (n = 3). Something that was generally mentioned was that participants found it easier to come up with the vitality-related stimulus words compared to the fatigue-related stimulus words.

Relatively Challenging. Participants reported the task of coming up with their own stimulus words to be challenging, because they had to take a moment of self-reflection to consciously notice what makes them feel vital or fatigued (n = 9). This required some thinking effort and the ability to turn inward and notice what comes up, but also the ability to abstract the feeling and turn it into a suitable word. Participant 11 (male, 21) described this challenge as follows: "Um, because I, I had to reflect on myself what makes me feel vital or fatigued in the day-to-day life or like in general as well. And um, so it did take longer than I thought".

Another aspect that was mentioned was that participants did not know how the application would look like since they had to come up with their own words *before* downloading the TIIM app and starting the IVY training (n = 1). Further, participants perceived it to be difficult to find a word that met all the criteria that were given, for instance that it was only related to either fatigue or vitality, or that it was only a single word (n = 3). One participant mentioned that they had too many words in mind and found it difficult to narrow them down to three (n = 1), while numerous participants said that they had a difficult time coming up with their own stimulus words, because they were already satisfied with the existing list of words and felt that their personal feelings of fatigue were represented by the listed words (n = 11). This was summarised well by participant 19 (female, 22): "So, I think that made it harder, especially because there were already a lot of words which I would have chosen. So, coming up with even new ones was just a bit more challenging".

Participants reported the wish to have the application available in their own language. They argued that doing the training in one's mother tongue increases familiarity and that translating the words added an extra (thinking) step before the word could be associated with either the "self" or "other" category (n = 3).

Ranking Strategy

A multitude of strategies was used to determine the ranking order of the ten stimulus words. The largest number of participants explained that they ranked the existing stimulus words according to their gut feeling or intuition (n = 20). They often had an intuitive idea of which word they associated most with their personal vitality or fatigue feeling, or which words were more meaningful and specific to them than others.

Another strategy was to categorise the words (n = 4). Participants explained that they saw a pattern in the list of existing stimulus words, such as words more related to physical aspects of vitality or fatigue (e.g., fit) and words more related to mental aspects of vitality or fatigue (e.g., attentive). For them, it was unreasonable to put words of the same kind on different ranks, instead, they considered the category they felt the word fitted into.

Other participants described that they remodelled the words at least one time (n = 2). They said that they came up with an initial version of the ranking order and then reallocated the words a couple of times until they felt satisfied with their order.

Some participants mentioned that it was much easier to find the words that they felt belonged to the top and the bottom, making them start with those (n = 4). They reported that the words in the middle were most difficult to assign a rank number and explained that the words on the middle ranks were more likely to change position than the highest and lowest ranked numbers.

Summarising, it stood out that most participants relied on their intuition or gut feeling when choosing the ranks. Other strategies were used less frequently. Generally, it could be observed that participants often combined the strategies mentioned above to come to a ranking order in accordance with their liking.

Motivation

When participants were asked whether they would prefer an imagined standard version without the option to personalise compared to the version of the IVY intervention they engaged in, all 20 participants answered that they would rather work with the personalised version of the IVY intervention. However, using the personalised version was not necessarily connected to increased motivation to engage in the CBM training. 40% of the participants in the interview sample stated that the fact that the intervention was personalised increased their motivation, whereas 60% of the participants answered that the personalisation did not cause a difference in motivation for them personally. The participants who reported increased motivation mentioned the familiarity of words as well as feeling more committed to be reasons for their heightened motivation. Those, who did not notice a difference said that they were curious about the implementation of their words, but did not feel more motivated in the long run.

Overall, 19 out of 20 participants from the interview sample completed all 6 training sessions, indicating high motivation. This number however, is to be interpreted with caution since it became apparent during the interviews that many participants engaged in the intervention for the sake of the study and not based on their own interest.

Increased Motivation. Participants described that recognising their own words in the training helped them stick to it, because they were looking forward for their own words to appear again in the session (n = 1). They reported that they were highly aware of their personal words, which often evoked feelings of personal connection and familiarity (n = 2).

> Uh, yes, because I remember that every time, I saw a word that I wrote down myself. I, uh, kind of. It gave me more of, um. I don't even really know how to say it, but it's more like I was more aware. So, it really helped me get through the entire exercise, I think. (Participant 2, female, 20)

Another aspect considering the motivation to engage in the training was the fact that it was personalised. Participants reported that their commitment was higher, since they knew the application was compiled only for them (n = 3). Participant 17 (female, 24) summarised this the following way: “So, it also maybe gives a bit of motivation to just continue with it because it's personalized for you.”

Participants said that it increased their motivation that the personalised CBM training consisted mostly of words they could very well relate to and that the frequency of the words mirrored how much they liked the word (n = 2).

No Difference in Motivation. Participants reported that they were curious to see how their own words would be implemented in the CBM training eventually. They appreciated the possibility to come up with their own words, but did not feel an increase of motivation to actually do the three-day long training (n = 3).

> I was like, in the beginning, I was interested to see how they would show up and how, like, how they would be integrated into the training. But, I mean, after I did it once or two times, it was I don't know how it would have been if they weren't there, but I don't think that I actually thought of that and actively had it as a motivation point, to be honest. (Participant 20, female, 23)

One participant reasoned that they felt satisfied with the already existing words, so that they would not see a big difference between the standardised and the personalised version of the IVY intervention (n = 1).

Less than 6 Sessions. One participant, out of the 20 participants taking part in the interviews, completed only 1 session instead of the expected 6 sessions. The participant explained that their low number of training sessions was due to time and technical constraints. It remains unclear whether the motivation to do the training was only affected by these external

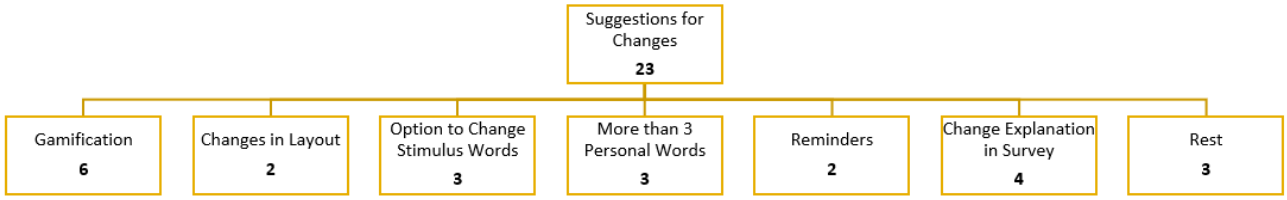
factors or, whether there might have been other causal factors for completing only one training session.

Suggestions for Changes

During the interviews, many participants came up with suggestions and concrete ideas for changes for the IVY intervention, eliciting 23 codes in total (see Figure 4).

Figure 4

Code "Suggestions of Changes" Including Subordinate Categories and Their Frequency



It was suggested to turn the training more into a game so that the category "Gamification" emerged (n = 6). One idea was to make the bubble in the middle of the screen a character, such as a smiley face. Another idea was to create some variety with regard to the types of exercises, for example by making a "connecting exercise", where participants would connect fatigue- and vitality-related words with either the "self" or "other" category. Participant 5 (female, 22), for instance, said "So, I'd say like a little bit more of a variety of what you're doing a little bit more like a game instead of just swipe, swipe, swipe". Additionally, participants expressed the wish for a progress bar to see how far they have come. It was mentioned that some kind of tracking mechanism or reward system could be beneficial to increase feelings of accomplishment and ultimately, adherence.

Considering the opportunity to personalise, participants suggested that the option to change one's stimuli words during the intervention could be a valuable addition to the application (n = 3). This could have several benefits, such as increased feelings of control over the process, the possibility to change stimulus words that are not considered suitable anymore, and some variety in stimulus words, making the training less monotonous.

> Yes, I would have liked to change that, and if I had done it over a longer period of time, I think I would have liked to update the stimulus words, especially the negative ones, from time to time, because then maybe something else was very present during the week, which then drained your energy or something. (Translated from German, participant 1, female, 26)

Further, some participants suggested to come up with more than three personal words for two reasons (n = 3). Firstly, it was perceived as beneficial for training purposes to be exposed to more personal stimulus words. Secondly, it was suggested to come up with a lot of personal words to reflect upon those and choose the most personal relevant ones for the final training, resembling the ranking exercise only with self-chosen words.

Since many of the participants had problems with the choice of unambiguous words that belonged only to either of the two categories, it was suggested to change the text in the survey that explained how to come up with the personalised stimulus words (n = 4). Participants wanted to have more guidance and were looking for a simple description of the goal and working mechanisms of the CBM training as well as the functions of the application.

Other suggestions included the implementation of reminders (n = 2), changes in the layout of the application regarding the colour choice (n = 2), or adding a countdown before the first word appears on the screen (n = 1). In addition, one participant gave the advice to create different training sessions with varying lengths, so that it becomes possible to deliberately choose to engage in a longer or shorter training session (n = 1). Another participant expressed the wish to always end the training with a positive word (n = 1).

Discussion

Summary and Explanation of Findings

The aims of this paper were manifold and included three main aspects that were investigated in two sub-studies. The first aim was embedded in the research question of the first sub-study. Its aim was to determine, whether the personalised CBM intervention was effective in correcting fatigue bias to a vitality bias in a sample of young adults following the CBM training for three consecutive days. The second and third research question were part of the second sub-study of qualitative nature. The aim was to explore to what extent participants perceived the personalised version of the IVY intervention as acceptable. Moreover, it was investigated how participants perceived the process of personalisation, including the impact of the personalisation on user engagement as well as the extent to which participants chose suitable stimulus words.

Effectiveness of the IVY intervention

Firstly, it was investigated whether the personalised version of the IVY intervention was effective in strengthening vitality bias or modifying a fatigue bias into a vitality bias. Results showed that the three-day-long intervention led to significantly improved scores on the IAT, meaning that participants' fatigue bias could be corrected into a vitality bias or their vitality bias

could be strengthened. This finding is supported by literature on the effectiveness of CBM interventions utilising AAT in the treatment of substance use disorders (Garfield et al., 2021; Manning et al., 2020). In addition, studies using CBM to modify attentional and interpretation biases targeting anxiety symptoms or emotional vulnerability stress the beneficial effects of CBM, supporting the current finding (Grafton et al., 2017; Mobini et al., 2013).

Considering the results of the explicit measures in the form of questionnaires, no significant changes from pre- to post-measurement occasion could be found. This means that fatigue symptoms did not significantly decrease, and feelings of vitality did not significantly increase after the intervention. In the present study, a relatively small proportion of 14% of participants indicated that they previously suffered or currently suffer from a medical condition related to strong fatigue symptoms, which implies that the majority of participants does not possess a self-schema of themselves as a fatigued person. Yet, one needs to consider that fatigue is a universal experience known by most people (Jason et al., 2010; Landmark-Høyvik et al., 2010). The IVY intervention was developed in a co-creation process with breast cancer patients suffering from severe fatigue symptoms, therefore its target group are those who are likely to possess the "self-as-fatigued-identity" bias (Wolbers et al., 2021). According to Beurskens et al. (2000), people suffering from the chronic fatigue syndrome yield an average score of 113.1 on the CIS. Participants in the current study scored significantly lower than this with an average score of 71.19 (pre-test). Thus, one explanation for the lack of change on the explicit level could be that participants' fatigue symptoms were not exceptionally high from the beginning, limiting the possibility for change.

Another reason for the lack of change in explicit measures could be the short time frame of the intervention (i.e., six sessions). Even though shorter CBM interventions have proven to be effective, as shown in the study conducted by Wierset al. (2011), other researchers opted for a longer duration of the training and implemented 12 sessions in total (Eberl et al., 2013; Laurens et al., 2020; Manning et al., 2020). In all studies, changes on the behavioural level could be found. For now, it remains unclear whether the length of the CBM training in the current study was related to the lack of change on the explicit level (i.e., conscious experience of vitality and fatigue). Additionally, there is evidence showing that previous CBM interventions were highly effective on the implicit level, but less powerful on the symptom level of different psychopathologies, such as depression or eating disorders (Jones & Sharpe, 2017; Matheson et al., 2019).

Process of Personalisation

One of the aims of this research was to gather insights into the personalisation process of the participants using the IVY intervention. As recommended by Laurens et al. (2020), the current study provided the possibility to personalise the stimulus words that were part of the CBM training. Overall, personalising the stimulus words was perceived as beneficial, because it led to increased subjective meaningfulness due to a personal connection to the words and heightened feelings of self-efficacy based on the possibility for participants to exert control over ordering and choosing their stimulus words. These findings align well with existing knowledge on the importance of tailored health interventions that fit the user and the context (van Gemert-Pijnen et al., 2018).

In terms of the personalisation methods, the ranking of existing stimulus words was perceived as easy and straightforward, however, the lack of personal connection was mentioned as a drawback of this personalisation method. While the freely chosen stimulus words were reported to be personally relevant and connected to participants' feelings and daily life, the method was perceived as challenging, because it required some self-reflection. Participants had to turn inward, notice what comes up, and turn the intuitive response into a suitable word. Especially in comparison with the ranking exercise, choosing one's own stimulus words required mental effort, increasing the perceived difficulty of the task. Constructivist learning theory, however, suggests that individuals create personal meaning by actively engaging in knowledge construction, possibly increasing motivation and engagement (Chuang, 2021). Combining this knowledge with the fact that participants reported heightened feelings of self-efficacy due to the possibility to exert control over their stimulus words, the pros (i.e., personal relevance, higher motivation) might outweigh the cons (i.e., thinking effort) of the personalisation method in this case. Findings emphasise the fine balance between a highly tailored training experience and maintaining ease of use. Opting for the simplified process possibly reduces user engagement or personal relevance. Based on the derived knowledge, future research can weigh both options with the aim to take an informed decision of which personalisation method seems most suitable for the purpose of the study and their target group.

Further, it was investigated *how* participants came up with their stimulus words. One strategy that was used was contextual thinking as participants imagined scenarios that caused them to feel fatigued or thought about how they experienced previous situations when being tired. Further, participants made use of free association when writing down the first words that came to their mind while thinking about vitality/fatigue as well as semantic association where participants thought about words connected or similar to vitality/fatigue. The choice of words

was described to be influenced by present conditions, such as illness or exam period. The findings suggest that the personal context of each participant is important in steering thoughts to particular situations connected to fatigue or vitality, drawing inferences from their personal pool of experience.

The importance of the context also plays a major role in the choice of ambiguous stimulus words, which was identified to be the main problem in the personalisation process. Participants chose their stimulus words based on the aforementioned strategies without knowing how the stimulus words would be integrated in the intervention. This led to a number of stimulus words which fitted both, the fatigue and the vitality category. During the interviews participants explained that they noticed the problem of ambiguity only while doing the CBM training. They were surprised when they categorised a stimulus word that they initially chose for the opposite category wrongly. This finding implies that information about the setup of the intervention is crucially important when aiming at minimising the risk for the choice of inappropriate words. Possible solutions for this problem can be found in the section “CBM Improvement”.

Generally, the level of difficulty when choosing stimulus words was often measured by the time it took participants to complete the task. For most participants it was easier to come up with vitality-related stimulus words compared to the fatigue-related stimulus words. The kind of words chosen for fatigue and vitality were strongly related to student life. Latter two points can be considered a reflection of the life period of the participants (M_{age} = 22.95), who mostly do not suffer from severe fatigue symptoms and whose central focus lies on their personal and professional development.

Looking at the strategies participants used to order the existing stimulus words according to their preference reveals different approaches. Most participants reported that they relied on their intuition, which can be considered “a gut feeling based on unconscious past experience” (Dijksterhuis & Nordgren, 2006, p. 105). Taking into consideration the goal of CBM to change implicit cognitive processes, the finding highlights a benefit of the strategy to rank existing stimulus words. Other participants categorised the stimulus words into groups, remodelled the order a couple of times, or started with the top and bottom words since these seemed to be easier to allocate. Most people did not only use one of the mentioned strategies, but combined them. From the findings, it can be concluded that the decision-making processes varied with the strategies either being of intuitive or analytical nature.

In the current study the adherence rate was high, with 90% of the participants from the sample completing all six sessions, indicating high motivation and user engagement. While

every participant from the interview sample indicated to prefer the personalised version of the IVY intervention over an imagined standard version, only 40% said that the personalisation increased their motivation to engage in the training. The participants who indicated no increased motivation were curious to see how their personal stimulus words would be integrated in the training, but did not feel increased motivation in the long run. These findings suggest that the high adherence rate was not necessarily connected to the option to personalise. During the interviews it became apparent that some participants engaged in the training based on the commitment to the study, but not necessarily because they were intrinsically motivated. Combining these insights with the finding that a non-negligible number of participants (40%) preferred the simpler personalisation method of ranking, it could be an option to put a deeper focus on personalisation methods utilising existing stimulus words.

Acceptability

Another aim of the study was to gather insights into the participants' acceptability of the personalised IVY intervention. A previous usability study conducted by Geerts et al. (2023) investigated the acceptability of a CBM training which targeted fatigue bearing a close resemblance to the intervention of the current study. Yet, differences in samples need to be acknowledged. While Geerts et al. (2023) included patients suffering from kidney disease and healthcare professionals, the sample of the current study consisted of a healthy population of young adults. In the following section it is examined whether previous findings could be confirmed and new insights are added.

In accordance with current findings, patients in the study conducted by Geerts et al. (2023) described the intervention to be fun and saw the training as a game. Health Care Professionals added that the setup of the training could be considered "charming and not burdening for patients" (p. 6). Participants from the current study liked the game character of the intervention as well which was accentuated by the setup of the application including the swiping mechanic and immediate feedback. Both, participants in the current study and patients participating in the study of Geerts et al. (2023), especially stressed that the CBM training was straightforward and easy to use. This point, however, was also described to be the biggest drawback of the CBM training, because the repetitive nature of the task made many participants feel bored.

Participants in this study approached the CBM training with differing attitudes. While some participants faced the intervention with openness and curiosity, others expressed scepticism, which was partly grounded in external factors, such as time constraints, and partly related to internal factors, such as resistance towards the suggested method of CBM. Still,

participants were positive about the idea of widespread use, because they argued that the intervention should be tested over a prolonged period of time or might prove effective for others, reasons also given by patients from the study by Geerts et al. (2023). Others explained that they would support the wider implementation under the premise that its evidence is confirmed.

In terms of effects of the IVY intervention, Geerts et al. (2023) found that none of the patients taking part in their study experienced direct effects resulting from the CBM training. In the current study, participants explained that they perceived an increased focus on and higher awareness of the stimulus words, especially the vitality-related, positive words. Further, it was mentioned that they subjectively became faster and more accurate in categorising the stimulus words into the "self" and "other" categories towards the end of the training. While these minor direct effects could be observed, none of the participants reported changes in explicit fatigue or vitality levels, which is congruent with the results from the VITA-16 and the CIS.

Considering the technical aspects, 60% of the participants in the interview sample experienced technical difficulties, with the majority being subjected to long loading times. Research found that technical problems, such as issues with the Wi-Fi connection or difficulties logging in, can hinder participation and thus, decrease adherence (Oakley-Girvan et al., 2022). This can be connected to findings from the current study since participants' overall satisfaction with the IVY intervention also depended on the proper functioning of the application.

Further, the length of the intervention as well as the frequency and duration of the training sessions was discussed. Literature on the number of training sessions needed to achieve the desired goal of cognitive bias modification varies in what is proven to be effective, however, participants' subjective view on the matter mirrored that more than six sessions and thus, a longer intervention, was perceived as valuable (Eberl et al., 2013; Manning et al., 2020; Wiers et al., 2011). Participants agreed that two sessions per day were manageable, however, in terms of the length of one training session, perceptions differed to a great extent, since 50% thought the training sessions (i.e., 120 words) were too long, while the other half was satisfied. Research conducted by Zhang et al. (2019) compared the number of trials in studies utilising CBM training for the treatment of patients with substance use disorders, ranging from 80 to 240 trials. The ideal length of a session does not yet seem to be determined.

CBM Improvement

The first suggestion for improvement does not directly relate to the CBM training incorporated in the IVY intervention, but rather concerns the descriptive text in the survey on how to come up with personal stimulus words. Based on the answers of participants from the

interview sample, the text should be more explanatory in nature, providing a simple explanation of the goal and working mechanism of CBM as well as the functions of the TIIM application. Laurens et al. (2020) support this suggestion since they stress the value of explaining the rationale behind CBM and the importance of repeated training to participants.

The wish for more guidance in the selection process of stimulus words might also imply a lack of clarity on how the intervention is set up and what it is like to engage in the training, so that it could be beneficial to show a demo version of the IVY intervention before the actual start of the training. Patients in the study conducted by Geerts et al. (2023) also suggested the implementation of an instruction video. Showing such a demo version could also help to reduce the number of ambiguous stimulus words since it became apparent that participants would have chosen other words in hindsight, knowing how the CBM training worked eventually. Further, examples of inadequate stimulus words including an explanation on what makes some words less suitable than others (e.g., because they can be connected to vitality *and* cause one to feel drained, see "partying", "socialising") could be another way to increase the awareness for the importance of unambiguity.

Other ways to deal with the selection of stimulus words could be to give the opportunity to add personal stimulus words without making it a mandatory step, or to provide a list of more than ten stimulus words, from which the most fitting ones can be chosen by participants. Especially the participants who described to be satisfied with the existing list of words would be taken into consideration in this case. It might be valuable to add the opportunity for feedback on the freely chosen stimulus words of the participants or to incorporate the option to change stimulus words during the intervention.

Another suggestion for improvement that was mentioned by participants, but also by previous researchers, is the application of more engaging formats, meant to increase motivation and adherence (De Voogd et al., 2018; Geerts et al., 2023; Laurens et al., 2020). Concrete suggestions by participants from the current study were for example the implementation of a progress bar, or some other kind of tracking mechanism as well as a reward system to make the experience more fun and gratifying. Laurens et al. (2020) elicited findings leading to similar conclusions. In the study conducted by De Voogd et al. (2018), feedback, progress bar, financial compensation, and reminders were implemented, yet the researchers point out that other motivating features, such as gaming elements, could prove to be beneficial. In the present study, gamification could include the development of game mechanics, a backstory, and fitting aesthetics, as it was done by Boendermaker et al. (2015).

Strengths and Limitations

The current study provides comprehensive findings with regards to different aspects of the personalised version of the IVY intervention, including insights into the effectiveness of the CBM training, knowledge about the user's acceptability of the intervention as well as the process of personalisation. In terms of the user's acceptability, the current study confirms findings from a previous usability study, even though samples differed to a great extent. This shows that certain features of the intervention are perceived relatively similar by different populations, providing strong and informative results with regards to the acceptability of the CBM training. So far, the acceptability of CBM interventions has not been researched extensively, so that the current study can be considered a valuable addition to existing research (see Beard et al. (2012) and Geerts et al. (2023)). Moreover, the current study does not only establish the effectiveness of the personalised intervention, but also provides in-depth information about how participants personalised and which challenges they encountered. The analysis of the personalisation process presents new and highly valuable results with the aim to tailor the intervention even more to individual participants in the future.

The present study also has some limitations. Firstly, the effectiveness of the IVY intervention was investigated without the inclusion of a control group. Another point was that the target group consisted of young adults, who were mostly healthy and vital. The eHealth application was developed with the aim to reduce fatigue symptoms in cancer patients targeting the "self-as-fatigued" identity bias (Wolbers et al., 2021). Since this bias is not expected to be found in healthy individuals who do not possess a self-schema of themselves as fatigued, the intervention might yield different results among the target group it was initially developed for. Thirdly, unexpected technical difficulties due to overload of the TIIM application that was not anticipated, caused long loading times and problems opening training modules, which led to a less pleasant experience with IVY for some participants.

Future Research

Future research should aim to combine the information from the two sub-studies of this paper, for example by using a mixed method approach, combining quantitative data with findings from the interviews. In the present study, the mixed method approach has not been applied due to the small degree of intersection between quantitative and qualitative findings. However, in the future, it could be valuable to take a closer look at those participants who did not benefit from the intervention (i.e., their vitality bias was not strengthened or their fatigue bias was not modified to a vitality bias). The careful analysis of their interviews might reveal patterns that provide cues with regards to possible barriers or characteristics that hinder the

intervention to be effective. These findings could be starting points for further investigation and therefore, be highly useful in improving CBM trainings.

Moreover, studies in the future should not only include an experimental group, but also a control group to establish a baseline against which the effects of the experimental treatment can be compared and to ensure that differences in results are due to the IVY intervention itself. A replication of the current study in a clinical setting can be considered beneficial to test the effectiveness of the personalised IVY intervention among the target group it was initially developed for. Shortcomings of the current study should be addressed to create an intervention that is adapted to the participants' needs in the best possible way. This includes revising and updating texts in the survey, adding a demo version of the intervention, implementing measures to avoid ambiguous stimulus words, and the gamification of elements within the CBM training. A deeper examination of the personalisation methods might prove to be useful with an emphasis on the free choice of stimulus words. The optimal number of training sessions as well as the ideal length of a single session is to be investigated further to increase the positive effect of CBM in the future.

Conclusion

The current study showed that the personalised version of the IVY intervention was effective in correcting a fatigue bias to a vitality bias. Overall, the CBM training was accepted by the participants and can be considered a low-threshold intervention which was perceived as easily accessible and flexible to use. The findings about the perception of the personalisation process were valuable for future developments of the IVY intervention. Participants appreciated that the stimulus words integrated in the intervention felt personally relevant, which increased their commitment and motivation. Generally, choosing one's own stimulus words was perceived as more meaningful, but also as more challenging, while the ranking exercise was seen as easy and straightforward, but also as less personally relevant. The biggest issue that appeared was the choice of ambiguous stimulus words, which can be solved by changes in the explanatory survey text as well as the implementation of a demo version. The current study provides a comprehensive view on the first version of the personalised IVY intervention. Overall, the intervention can be considered a valuable treatment option targeting the implicit processes underlying fatigue symptoms. The personalised version of the CBM training increased user's feelings of self-efficacy and satisfaction, making its application in the clinical setting a promising next step.

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Appendix A

Participant Information Sheet

We are focusing on participants who are at least 18 years old and possess good English proficiency. Participants are required to have access to a laptop as well as a smartphone.

Participation is completely voluntary, and you can withdraw from the study at any time. Withdrawing from the study does not have any consequences. Collected data will not be used for any purposes besides this research.

There are no major risks associated with this study.

If technical difficulties may occur throughout the study, please contact one of the researchers.

Prior to the analysis of the data, all personal data will be anonymised and will be used for research purposes only. The data will be stored in a secure location. Your answers will be treated confidentially. They will not be shared with other parties than the researchers and the according supervisors. The final dataset is stored securely after the final report is submitted. All other data is deleted.

The research is conducted by Mette Meijer and Insa Holtkamp (BSc Psychology students at the University of Twente).

The study is approved by the Ethics Committee of the Faculty of Behavioural, Management, and Social Science at the University of Twente.

Thank you for your participation! Should you have any questions, remarks or concerns about this study, please do not hesitate to contact one of the researchers responsible for the study:

m.meijer-3@student.utwente.nl or i.k.holtkamp@student.utwente.nl

Appendix B

Informed Consent

- I confirm that I have read and understood the participant information relevant for this study.
- I understand that in order to take part in this study, I should be at least 18 years old and have sufficient English proficiency. I have access to a laptop and a smartphone.
- I understand that personal data about me will be collected for the purposes of the research study, and that these will be processed in accordance with data protection regulations.
- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected.
- I understand that my data is anonymous and will be stored on secure university servers. I understand that it will only be used by the researchers for research purposes.
- I agree to take part in this study.

Appendix C

Frequency of (Personalised) Stimulus Words in the Training

Table C1

Calculation Table for the Frequency of Stimulus Words

Vitality	Frequency	Fatigue	Frequency
Personal stimulus 1	4	Personal stimulus 1	4
Personal stimulus 2	4	Personal stimulus 2	4
Personal stimulus 3	4	Personal stimulus 3	4
Preference 1	4	Preference 1	4
Preference 2	4	Preference 2	4
Preference 3	3	Preference 3	3
Preference 4	3	Preference 4	3
Preference 5	3	Preference 5	3
Preference 6	3	Preference 6	3
Preference 7	2	Preference 7	2
Preference 8	2	Preference 8	2
Preference 9	2	Preference 9	2
Preference 10	2	Preference 10	2
Total	40	Total	40

Appendix D

Participant Information and Informed Consent Interview

Dear Participant,

in the past days you used the eHealth Application IVY to retrain your brain. You were asked to repeatedly pair fatigue-related stimuli with “other” and vitality-related stimuli with “self”. You were asked to personalise the application according to your individual preferences in two ways, by ranking existing stimuli according to how much the words appealed to you, but also by choosing three words freely. The first aim of our study is to find out whether the personalised version of the IVY intervention is effective.

The second aim of the research is to examine the feasibility and the acceptability of the IVY intervention. This is also the reason why we meet for the online interview today. I would like to find out more about the process of personalising and assess the practicality and limitations of the personalised version of the application. I would like to know how easy or difficult it was for you to find personal stimuli words and how satisfied you were with the training.

The study, including this interview, was approved by the Ethics Committee of the Faculty of Behavioural, Management, and Social Science at the University of Twente. The interview is going to take place online via zoom and last 15 minutes approximately. The interview can be held in English or German depending on what you prefer. By giving consent, you agree that this research is completely voluntary and that you understand that you can drop out at any point. In case you would like to withdraw from the interview, please let me know that you would like to quit participating. Withdrawing from the study will not have any negative consequences for you and all the data gathered thus far will be destroyed. There are no major risks associated with participating in the interview.

The obtained data will consist of a recording of the zoom session (audio and video). The recording is going to be transcribed (i.e., put into written form) and deleted afterwards. The transcripts will be the data source to be analysed. Prior to the analysis of the data, all personal data will be anonymised and will be used for research purposes only. The data will be stored in a secure way. Your answers will be treated confidentially. They will not be shared with other parties than the researchers and the according supervisors. The data will be stored securely after the final report is submitted.

This interview is either conducted by Insa Holtkamp or Mette Meijer, BSc Psychology students at the University of Twente. Should you have any questions, remarks, or concerns about your participation in the interview or the study, please do not hesitate to contact me via the following e-mail address:

i.k.holtkamp@student.utwente.nl

Thank you for your participation!

- I hereby confirm that I am 18 years old or older and have read and understood the information. My participation in this interview is voluntary.
- No, I do not consent and will not participate in the interview.

Appendix E

Interview Schedule

Research Question: To what extent do participants perceive a personalised version of the IVY application as acceptable?

Before I start the interview:

- ✓ Write down the ranking and personal stimuli words of the participant
- ✓ Double check whether information sheet and consent form have been filled in
- ✓ Ask which language (i.e., German or English)
- ✓ Ask for verbal consent

List of **probes** to be used to gain more in-depth answers:
- Interesting, can you tell me more about…
- Can you give me an example of that?
- So, I hear you say…
- Is that a good summary?
- Are there any more things to tell?

Recorded interview:

1. Some open starting questions

→ What are your thoughts about the IVY intervention, now that you have experienced it?

→ How satisfied were you with the experience? Why?

- try to find out a bit more about pros and cons; use probes

For later analysis, these are going to be focus points (among others):
- what did the interviewee come up with first?
- did they mention the possibility to personalise spontaneously on their own initiative

2. The Process of Personalising

I saw that you chose stimuli words x, y, z for fatigue and x, y, z for vitality.

→ How did you come up with these individual words?

(Possible "support" questions: Did you rely on the ideas given? Did you have something in mind immediately)

→ What makes word x a relevant word to you?

In the survey you filled out before the IVY training, you were asked to rate fatigue and vitality related words according to your preference.

→ How did you rank them? Did you notice that the words you rated higher appeared more often in the training?

→ Did the words in the training feel familiar to you?

→ Which way of personalising did you prefer? Ranking the existing words according to your preference or choosing your own stimuli words? Why?

→ Did the fact that you trained with a personalised version influence your motivation?

→ Imagine the application to be compiled of words from the standard list or maybe you remember the IAT from the surveys. Do you consider the possibility to personalise as valuable when comparing both options?

2. Acceptability

→ How easy or difficult was it for you to find personalised stimuli words for the IVY application? What made it so easy or difficult?

→ Are there any aspects of the personalised IVY application that you felt could be improved or enhanced to better meet your needs?

→ Do you think that the personalised IVY application that you used can be applied to a larger group of people the way it is now? Why or why not?

→ If not, what would IVY need to be feasible for widespread use?

→ Did you complete all sessions? If not, why?

→ What do you think of the number of training sessions? The frequency of training sessions? The duration of training sessions?

→ Did the TIIM app/IVY intervention work smoothly on your phone? (Which phone/operating system (Android, IOS, Windows phone) do you possess?)

→ What are your expectations about the effects?

→ Do you approve the personalised version of the IVY application? Why or why not? If not, what would IVY need for you to be able to approve the application?

Appendix F

Sensitivity Analysis

Running the linear mixed effect model for the IAT excluding outliers, a significant change of IAT scores from pre-test to post-test was found, indicating a beneficial training effect from fatigue bias to vitality bias (b = -.25, $t(36)$ = -4.11, $p < 0.001$, d = .71). The null hypothesis can be rejected. Comparing the two sets of results, it can be concluded that the outliers do not cause significant distortions in the data. However, effect size decreases from .83 to .71 (i.e., change from “high” to “moderate”) with the exclusion of outliers.

Running the Wilcoxon signed-rank test without outliers indicated that there was no significant difference between pre-intervention measurement occasion and post-intervention measurement occasion with regards to the VITA-16 scores, V = 441, p = .091. Therefore, the null hypothesis cannot be rejected. However, excluding the outliers led to a considerably lower p-value, suggesting that the first analysis (n = 42) might have been influenced by the presence of outliers.

The Wilcoxon signed-rank test ran without outliers indicated that there was no significant difference between pre-intervention measurement occasion and post-intervention measurement occasion with regards to the CIS scores, V = 227, p = .231, therefore the null hypothesis cannot be rejected. Comparing the two sets of results there is no reason to conclude that outliers cause significant distortions in the data.

Comparing the IAT scores from pre- to post-test, the effect size decreased from .83 to .71 (i.e., change from “large” to “moderate”) with the exclusion of outliers. The p-value of the VITA-16 changed considerably from p = .317 to p = .091. Overall, it can be said that the significance of results comparing the two analyses did not change.

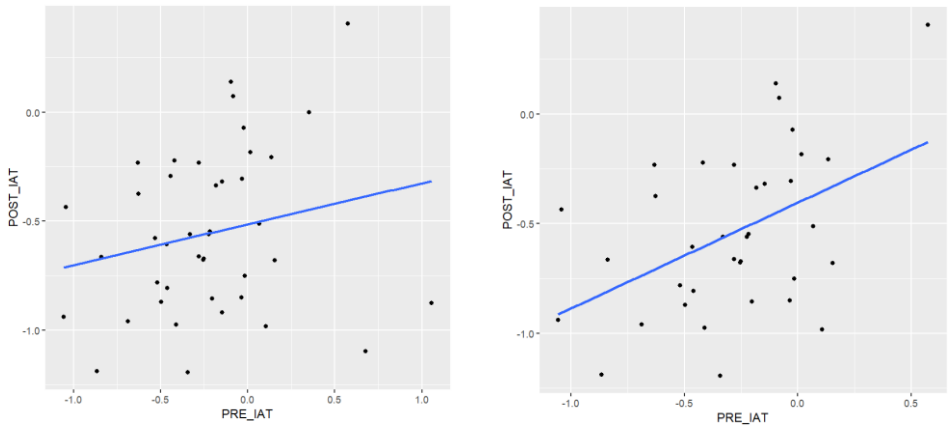
Appendix G

Parametric Assumptions

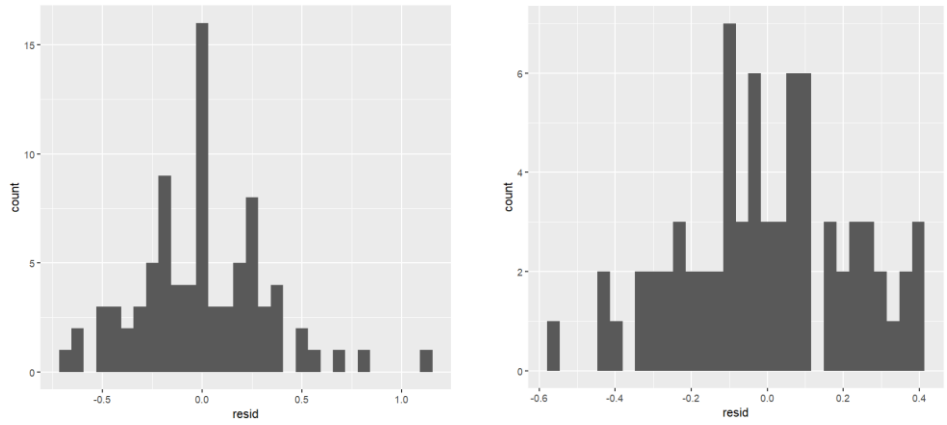
Figure G1

Graphical Representations of the IAT D-Scores to Check Parametric Assumptions of Dependency, Normality of Residuals and Homogeneity of Variance

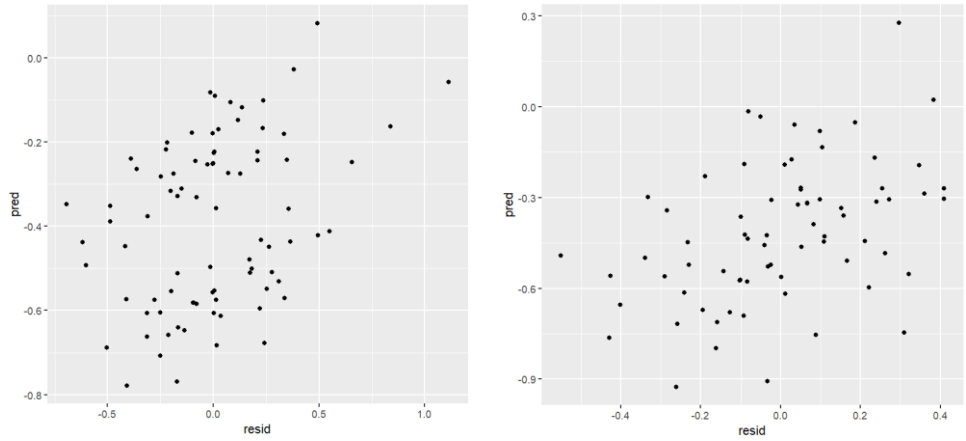
Dependency A B



Normality C D



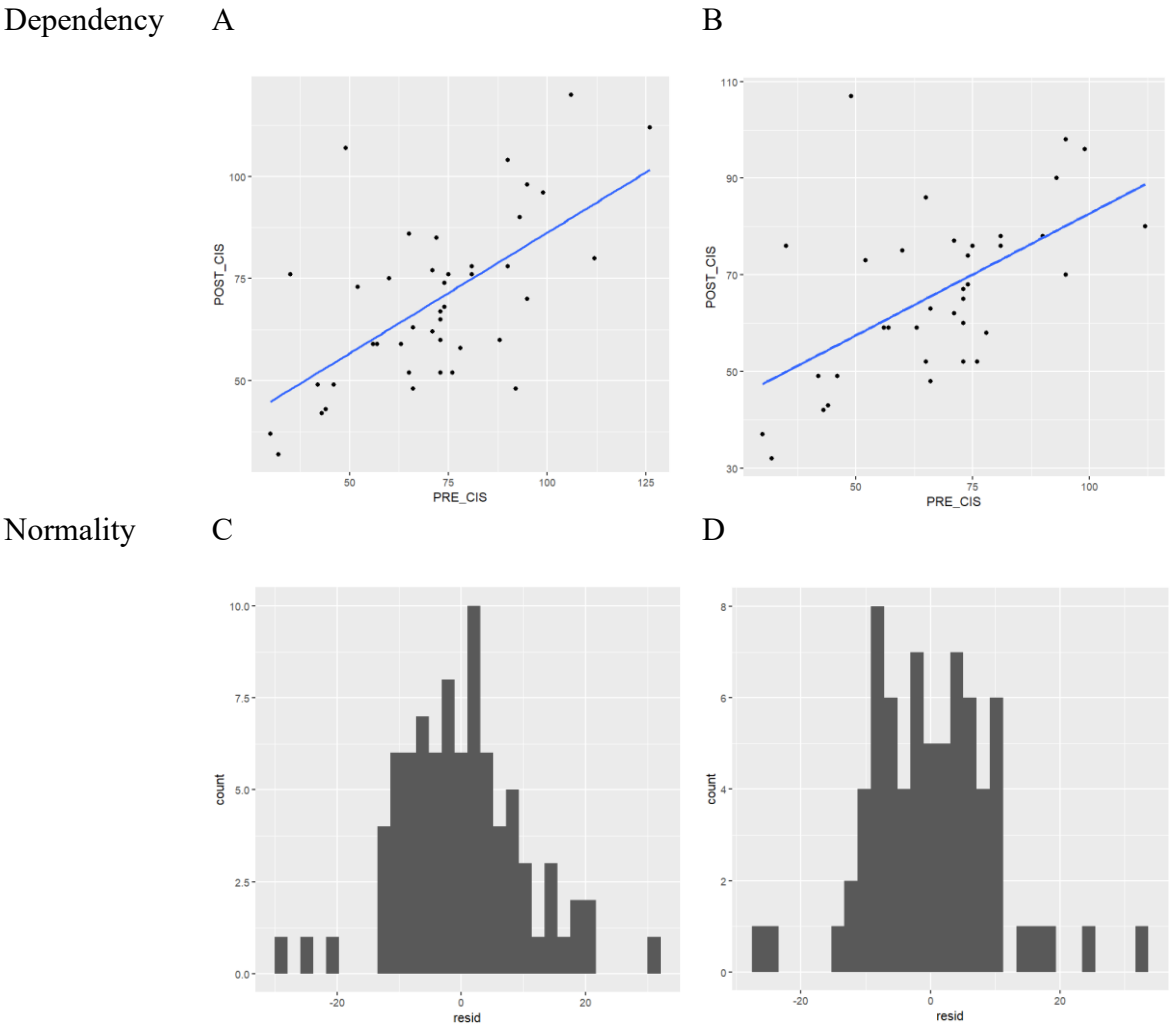
Variance E F



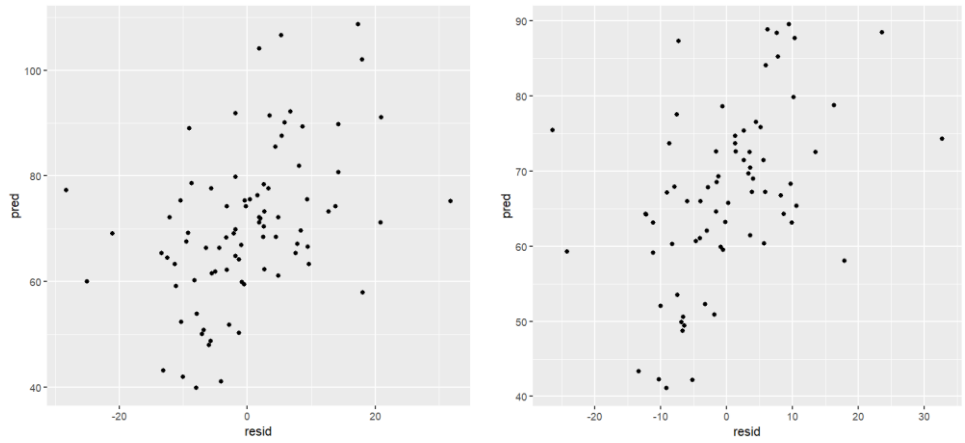
Note. Panel A and B: Scatterplot of pre- and post-scores of the IAT including outliers (A) and excluding outliers (B). Panel C and D: Distribution of Residuals including outliers (C) and excluding outliers (D). Panel E and F: Scatterplot of residuals and predictions including outliers (E) and excluding outliers (F).

Figure G2

Graphical Representations of the CIS Data to Check Parametric Assumptions of Dependency, Normality of Residuals and Homogeneity of Variance



Variance E F

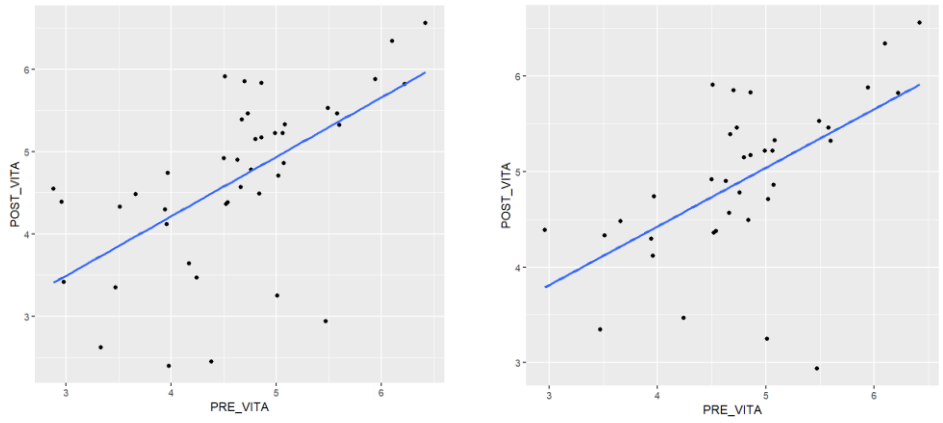


Note. Panel A and B: Scatterplot of pre- and post-scores of the CIS including outliers (A) and excluding outliers (B). Panel C and D: Distribution of Residuals including outliers (C) and excluding outliers (D). Panel E and F: Scatterplot of residuals and predictions including outliers (E) and excluding outliers (F).

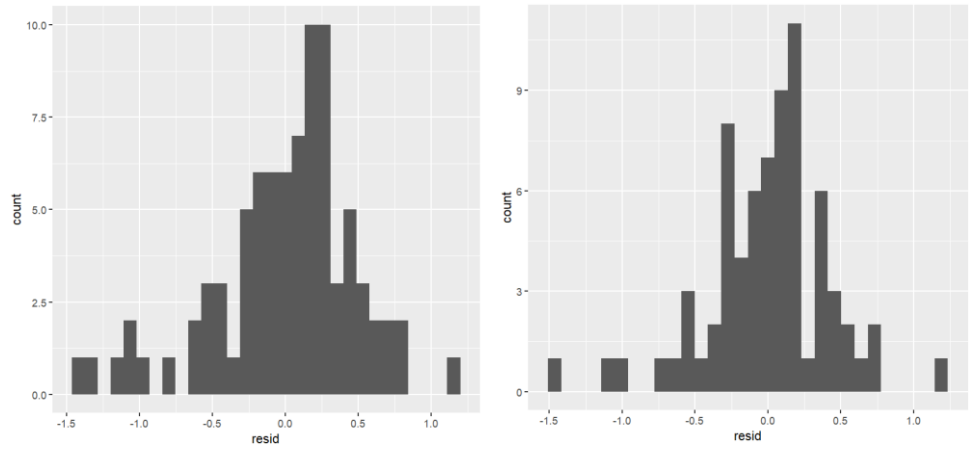
Figure G3

Graphical Representations of the VITA-16 Data to Check Parametric Assumptions of Dependency, Normality of Residuals and Homogeneity of Variance

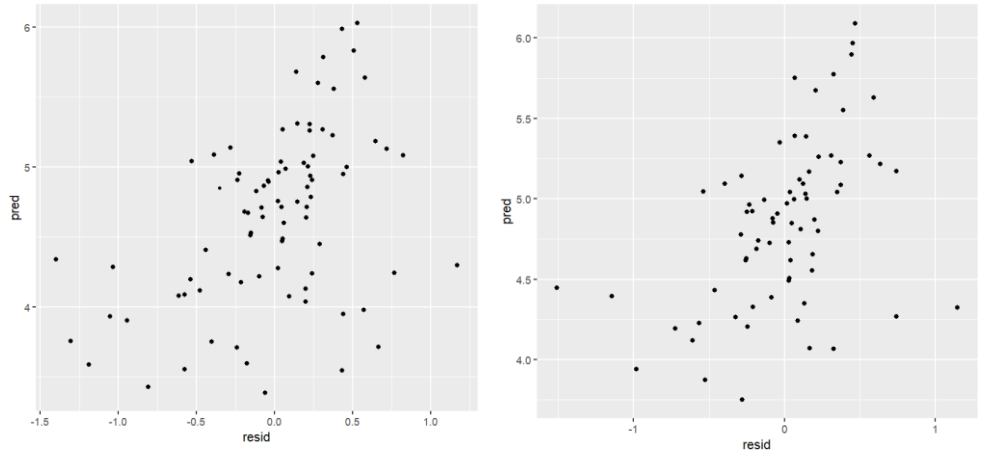
Dependency A B



Normality C D



Variance E F



Note. Panel A and B: Scatterplot of pre- and post-scores of the VITA-16 including outliers (A) and excluding outliers (B). Panel C and D: Distribution of Residuals including outliers (C) and excluding outliers (D). Panel E and F: Scatterplot of residuals and predictions including outliers (E) and excluding outliers (F).

Appendix H

Results "Acceptability"

Table H1

Table Showing Super- and Subordinate Codes belonging to "Acceptability" including Example Quotes and Their Frequency

Superordinate Codes and Subordinate Codes	Example Quote	Frequency
General Impressions		**n = 41**
Positive General Impressions		n = 29
Straightforward and easy to use	"Um, first of all, I thought it was a very easy process to use the app and to do the training. Um, once I had it on there and then, I mean, it is quite straightforward. You either put the word up or down, and it didn't really require much of my personal like effort or thinking to do it. So that was actually quite nice to be able to just I mean, it did take me maybe five minutes, 3 to 5 minutes, maybe around that, um, time. Yeah. But overall, it was rather pleasant." (Participant 20, female, 23)	n = 12
Use of own device and flexibility in terms of time and place	"I mean, everyone has a phone. Almost. You can, like, do it in your own time. On your own device, almost wherever you want. So, I think it would. Yeah. And the fact that it's quite a [Dutch word] Do you know what I mean, then? It's like a low threshold. Very easy to get used to it." (Participant 9, male, 22)	n = 3
No restriction of/interference with daily life	"So, so in general, it was the it was quite easy to remind myself to the intervention. So that wasn't like a big task or anything. And it wasn't like bothering me in the day-to day-tasks." (Participant 11, male, 21)	n = 1
Game character	"Yeah, I liked it a lot to, like, it was like a game because I always had my phone, like, on the table. And then I had my, like, finger and always, like, either switched up or down, so I felt like doing a game. So, um, it was pretty fun also. And I liked it a lot." (Participant 13, female, 22)	n = 3
Setup including swiping mechanic and immediate	"I think the app was made me think about it a bit. Actually, it was, first of all, kind of fun. It's weird to say, but I liked the	n = 3

auditory and visual feedback	noise and the swiping mechanic." (Participant 16, male, 24)	
Structure in daily life, well-being, motivation	"I liked that I started with the app and ended the day with the app." (Participant 12, female, 26)	n = 2
	"I found it really satisfying, because somehow I had the feeling that the intervention was good for me." (Translated from German, participant 1, female, 26)	
	"I liked it because I think it really motivated me somehow." (Participant 12, female, 26)	
Personalisation	"Well, I thought that it was really good for me, especially reading one's positive words, the personal ones especially since you always had in mind what just gives you energy" (Translated from German, participant 1, female, 26)	n = 4
Negative General Impressions		n = 12
Repetitive nature of the CBM training	"Well, it's very repetitive. You have to swipe 120 times that two times a day, and it's not intellectually challenging." (Participant 6, male, 23)	n = 8
Difficulties becoming familiar with the application and figuring out its setup and workings	"At first I found it quite a lot and confusing, because you had to get used to it first." (Translated from German, female, 26)	n = 2
Disliking the whole process of setting up and using the IVY intervention	"It was a weird, like the sequence was weird. The process." (Participant 3, male, 23)	n = 1
Disliking the basic layout of the intervention	"It didn't have a lot of options and stuff." (Participant 15, female, 23)	n = 1
Effects of the IVY Intervention		**n = 39**
Expected effects		n = 12
Improved scores on post-test survey	"Well, I expected to do better on the second test than on the first" (Participant 9, male, 22)	n = 2
Changes in daily life	"I was interested, if it would like, really help me feeling more awake." (Participant 4, male, 21)	n = 2
Changes in self-image	"I did expect that I would, I guess set myself in a positive or positive light at the end." (Participant 2, female, 20)	n = 3
Modification of unconscious processes	"I expected that I would be primed, like, unconsciously primed to associate myself more with vitality. Um, so going	n = 5

	into it, I thought doing this will most probably do this to me, like, lead to more vitality being associated with myself." (Participant 19, female, 22)	
Noticed effects		n = 11
Stronger focus on positive things (short-term)	"So, I didn't expect it to have an impact on my day-to-day life, I think it. It did in like a time spent around where I did it. Um, so I did the intervention and maybe then my, like, a little bit, my brain would be like, thinking about, okay, uh, the positive, uh, things or the vitality, uh, things I put in the app so it would, uh, like, reset my brain sometimes or, like, not a hard reset, but, uh, give myself give my brain a little bit of a break and, uh, get it, uh, focused on the important things again. So, it did have a small impact in the time frames that I did the application." (Participant 11, male, 21)	n = 2
Higher awareness of the words that were part of the intervention	"I thought it was really interesting to like to push those words towards yourself and connect them so much with me, myself and all of that. And I think now looking back at it, I still when someone tells me something about vitality or I mean, that doesn't really happen, but when I come across that word or any of those other words, I do instantly think of it and do instantly connect it." (Participant 20, female, 23)	n = 2
Subjective improvements in categorising words correctly and fast	"Um, so I was faster, as I said before, than I was before, and I also made less mistakes, I think." (Participant 2, female, 20)	n = 5
Increased productivity	"Uh, I really like to do, like, a smaller task in the morning, and that makes me really feel productive because I did something. So that was really helpful." (Participant 4, male, 21)	n = 2
Scepticism		n = 14
No reason for personal engagement in the training (even though it was acknowledged that the intervention might prove to be useful for others)	"Because I don't feel like I would personally need this or that this would have a concrete impact on me." (Participant 3, male, 23)	n = 5
Lack of visibility of clear results and progress	"So, I wasn't like, 100% convinced that it would work. I was 100% convinced that	n = 2

	I will, uh, try it out and give it a shot. Uh, if it works and, uh. Yeah. So. And also, since I didn't, like, see, my results should be. And I don't know if it actually, like, worked. Worked, uh, or just a little bit. Or maybe if I would do it for longer. So, I'm quite I'm not that sure about if it worked or not, but I'm. Not like, uh, it didn't work, so, it wasn't bad." (Participant 11, male, 21)	
Short time span	"I think it might be effective. Like doing these association tasks. But I wonder whether, like, at such a short time. That it works, that you have like enough time to let it sink in in a way." (Participant 9, male, 23)	n = 2
Injustice: Assigning fatigue-related stimulus words to "other"	"But at the same time, I also was kind of confused by why I should put negative words by other people or by others. Because then I kind of also gave like a negative. It gave kind of a negative effect to other people in a way." (Participant 2, female, 20)	n = 1
Lower likelihood of change due to an understanding of the logic behind the training	"But also, I don't think that swiping fatigue to others, it should be that you probably associate fatigue with not yourself and vitality with yourself. But I, I think because I can see the logic behind it, I can then dismiss, maybe dismiss it a little bit." (Participant 6, male, 23)	n = 1
High scores on subjective vitality before the start of the intervention already	"But before, I already ranked myself as vital. So doing the app and then afterwards I would say that my scores haven't changed so much just before. Just because before I already ranked myself quite high, I think I don't remember everything, but yeah, I think so. Okay. So, it may have had an effect, but maybe I'm not the best participant to test that effect." (Participant 19, female, 22)	n = 1
Resistance to the suggested method of CBM (contradicting usual coping strategies)	"Yeah. As I said, I don't feel like I need this. Like, I know very well in my life what I like, what I don't like, and I get my energy from things and a bit more people or like some time for myself. And I don't get it from associating things like, I mean, I also studied psychology, so I know I always say I know every problem that I have, so knowing it doesn't work like I know I	n = 1

	have to fix it on my own with things and not with the word association, because it's not that I don't know what I like and what I don't like, or what's good or bad in my life. It's just that I sometimes just don't do it. So, then I have to force myself and then it goes good again." (Participant 3, male, 23)	
Time constraints	"Because it takes so much time and I rarely have time." (Participant 14, female, 21)	n = 1
Openness		n = 2
Curiosity and willingness to try something new	"Um, it's quite a different approach to what I'm used to or what I'm normally doing. And it's, uh, kind of like, interesting to try out to, um, train your brain as well because, like, normally I do sports a lot and, uh, train my body and sometimes the mental side, but, uh, not that focused. And, uh, also not with an app or, uh, with other intervention tools." (Participant 11, male, 21)	n = 2
Technical Aspects		**n = 30**
Long loading times	"Because it was a bit slow, like every word. Then had to load in and load again and, like, it didn't really work properly. And it was. Yeah. Yeah, it didn't really work." (Participant 3, male, 23)	n = 9
Words being stuck	"And once, um, where I moved the word away and it just hung somewhere." (Participant 4, male, 21)	n = 4
Answers saved?	"But what I noticed was that, like when I there was the option of like, um, modules to complete and that have already been completed. And when I, when like when I clicked on those that already were completed, it said that there were none. And I was like, oh, did my like, answers go through?" (Participant 13, female, 22)	n = 4
Without Wi-Fi	"So not with Wi-Fi, it was a bit slower. So, like you maybe want to have it really quick so you can do like [swiping movement with hand]. And now sometimes I have to wait before it accepts the words. And then there came a new one. So, it was. We wanted this, but I think this also may be a problem of the data that I used it on, because	n = 2

	when I used it at home, it was really fast." (Participant 17, female, 24)	
Wrong order of modules	"And I think I also did the final session to first, like for day three." (Participant 9, male, 22)	n = 1
Worked smoothly	"I was satisfied. Like, um, I did my training session and, uh, yeah, I think it worked very well, so I'm really satisfied." (Participant 7, female, 20)	n = 3
Notifications	"So yes, I received a notification, but when I was doing something else and I couldn't take the time right now, I was able to do it later. And because I still had the notification on my phone, I also didn't forget it. So yeah, I think that was good." (Participant 19, female, 22)	n = 7
Training Sessions		**n = 58**
Number of Training Days		n = 13
Less than 3 days	"The number was all right. I think it's up to the fourth time I was like, okay, sure, I'm going to do this. And then on the third day I was like, okay, four times they were done." (Participant 5, female, 22)	n = 1
3 Days	"But I think doing that twice a day for three days like that was totally manageable." (Participant 19, female, 22)	n = 3
More than 3 days	"I think it was good just for this as research, but I think I would lengthen the amount of days just to really change your mindset. And three days is not enough time." (Participant 10, female, 25)	n = 9
Frequency of sessions per day		n = 21
Less than 2 sessions	"I think two a day is maybe a bit much because then you're like, it's not that it's too long, but it's. Like you have to make time twice and not everybody has it." (Participant 3, male, 23)	n = 4
2 Sessions	"I'd say two times, ten minutes a day is like. It's a good amount of time you could spend on it." (Participant 4, male, 21)	n = 14
More than 2 Sessions	"I would keep it shorter and then maybe once more of the day. So really that you have. Yeah. Maybe three. Uh, intervention the day or three? Three times training instead of twice. And	n = 3

	then only, I don't know, 30 words also or 50." (Participant 18, female, 24)	
Length of Sessions (i.e., 120 words)		n = 20
Appropriate length	"I think it was, um, it was definitely pretty doable because they don't really take too long." (Participant 2, female, 20)	n = 10
Too long	"I think it was a little bit too much, because there were 120 questions or swipes in each session. That was a little bit much." (Participant 6, male, 23)	n = 10

Appendix I

Self-Chosen Stimulus Words of Participants

Table I1

Stimulus Words for the Category "Fatigue" Chosen by Participants

	Stimulus Words Fatigue	
Konferenz	Loudness	Drained I
Prüfungsvorbereitung	Partying	Dejected
Menschenmenge	Alcohol	Foggy I
Karteikarten	Hangover	Deprived
Abtestat	Drama	Low
Versagen	Socialising	Gone
Studieren	Longtalking	Quiet
Leben	Discussion	Empty
Aufstehen	Obligations	Unmoving
Ausgelaugt	Travelling	Lonely I
Sportentzug	Driving	Alone
Studeren II	Commuting	Sad
Familie	Videos	Motiveless
Praten	Phone I	Unmotivated I
Vervelen	Shopping	Aimless
Telefoon	Complaining	Lazy
Verwachtingen (van anderen)	Doing nothing	Stressed
	Procrastinate	Bored
Verhuizen	Procrastination	Sleepy
Regen	Responsibility	Uncomfortable
Study I	Sleeplessness	Sick I
Studying I	Boredom II	Unhealthy
Lectures II	Loneliness II	Sleepless
Coding	Stress III	Depressed
Work	Hopelessness	Sluggish
Working	Negativity	Lethargic
Overworking I	Friction	Hungry I
Argument	Repetitiveness	Winter
Arguing I	Self-reproach	Raining
Fighting	Overthinking I	Dark
Conflicts	Anxiety	Crowds
Setbacks	Worry	Bed I
Disease	Worrying	Couch
Headaches	Fear	Sleep
Injuries I	Hunger	Energy

Table I2

Stimulus Words for the Category "Vitality" Chosen by Participants

	Stimulus Words Vitality	
Lotta	Sports IIIIIIIII	Friends IIIIIIII
Keramikmalerei	Sport	Boyfriend
Ponys	Volleyball IIIII	Activities
Reiten	Handball	Freetime
Fußballmannschaft	Football	Holiday II
Freunde	Ridinghorse	Vacation I
Snowboarden	Yoga	Camping
Wandern	Running IIII	Sun II
Skaten	Hiking II	Sunshine
Sporten	Biking	Dogs
Koken	Swimming	Sleep
Wijnen	Cyclying	Thriving
Volleyballen	Walking	Dynamic
Familie	Walk I	Robust
Bakken	Skiing	Resilient
Creeren	Mountainbiking	Happy I
Buiten	Gym	Prosperous
Stappen	Creativity	Inspired
Wandelen	Inspiration	Motivated
Singing II	Music III	Engaged
Drawing	Violin	Healthy II
Reading	Picknick	Social I
Socialising	Outdoor	Functioning
Talking	Outside	Satisfied
Helping	Nature II	Calm
Laughing I	Competition I	Peaceful
Travelling I	Competence	
Travel	Goalreaching	
Blossom	Purpose	