Individual Differences in Visual Sensory Processing and User-experiences of Web-Based Interventions

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INDIVIDUAL DIFFERENCES IN VISUAL SENSORY PROCESSING AND USER-EXPERIENCES OF WEB-BASED INTERVENTIONS

Abstract

Background. Low uptake and adherence rates of web-based interventions may result from low user engagement and perceived system usability. A possible method to enhance user-experiences of web-based interventions involves tailoring its health messages to individual users. Although the approach is valuable, it could be improved by including design-aspects. Namely, the design of web-based interventions may influence user-experiences through individual differences in visual sensory processing. Resultingly, the present study tempted to unravel the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions.

Methods. The present study utilised a cross-sectional survey design, in which 45 participants filled in a questionnaire based on screenshots of four web-based interventions from the eHealth platforms *MindDistrict* and *TherapieLand* which were paired based on topic. The questionnaire contained measures on visual sensory processing, expected user engagement, perceived system usability, a self-developed measure on visual sensory appeal, and a final rating of the eHealth platforms, as well as open questions on first impressions and the perceived attractiveness of visual stimuli (or stimulus-evaluations). Scores on visual sensory processing were correlated with the other variables. First impressions were used to identify valued design-elements, and stimulus-evaluations were used to evaluate the perceived attractiveness of visual stimuli and their contributing properties.

Results. Four out of eighty correlations were found to be significant. Results demonstrated negative relationships to exist between hyposensitivity with the final ratings of *MindDistrict*, and (visual) hypersensitivity with the visual sensory appeal of *MindDistrict*. Regarding qualitative findings, the majority of participants were found to value the simplicity of designs. Moreover, differences were found in the selection of attractive and non-attractive properties of images. Participants also provided differential descriptions of their colouring.

Conclusion. Although the quantitative findings were limited and contradictory, the qualitative findings provided valuable implications. Firstly, the present study raised the question whether a ‘less is more’ principle may be at play for all users of web-based interventions, as reducing visual clutter may support the speed and ease of goal obtainment. Secondly, the present study brought into question the contribution of positive emotions displayed by individuals, of which especially a smile, in enhancing the perceived attractiveness of visual stimuli in web-based interventions.

INDIVIDUAL DIFFERENCES IN VISUAL SENSORY PROCESSING AND USER-EXPERIENCES OF WEB-BASED INTERVENTIONS

Introduction

To account for higher healthcare costs and reduced availability of trained personnel, eMental Health is becoming increasingly relevant (Ossebaard & Gemert-Pijnen, 2016). eMental Health may be defined as usage of the Internet and associated technologies to improve mental health and well-being (Gemert-Pijnen, Kelders, Kip & Sanderman, 2018). A frequently used eMental Health technology includes web-based interventions. Web-based interventions are self-guided interventions over the Internet with which users may enhance their mental state (Murray, 2012). Web-based interventions may be fruitful in accounting for higher costs and lacking personnel, as they allow for the use of blended care (Batterham et al., 2015; Ossebaard & Gemert-Pijnen, 2016). Blended care involves the utilisation of both face-to-face and web-based treatment in mental healthcare practices (Ossebaard & Gemert-Pijnen, 2016). Particularly, the benefit of blended care relates to the reduction of additional clinician-time, as non-crucial treatment may be provided through the Internet at all times (Batterham et al., 2015; Gemert-Pijnen et al., 2018; Massoudi et al., 2017). Despite the advantages for healthcare organisations, studies suggest that uptake and adherence rates of web-based interventions amongst the user-base is relatively low (Cuijpers & Schuurmans, 2007). Hence, further research is needed to establish how web-based interventions may be made more appealing for the user.

A reason for low uptake and adherence rates of web-based interventions may be a lack of user engagement (Alkhaldi et al., 2016; Ludden, Rompay, Kelders, & Gemert-Pijnen, 2015; Torous et al., 2018). User engagement relates to the experiences users may have while interacting with an eMental Health technology, and the users' willingness to interact with the eMental Health technology for extended periods of time (Kelders & Kip, 2019; Lalmas, O'Brien, & Yom-Tov, 2014; Torous et al., 2018). Herein, user engagement was found to include three components: a behavioural component (e.g. routine; ease of use), a cognitive component (e.g. perceived ability; needed mental effort), and an affective component (e.g. attractiveness) (Kelders & Kip, 2019). The relationship between user engagement, and uptake and adherence rates is believed to be mediated by user motivation (Krebs & Duncan, 2015; Woldaregay et al., 2018). That is, users who experience greater engagement with a web-based intervention may be more motivated to utilise the web-based intervention, which in turn enhances the likelihood of the user to take up and adhere to the web-based intervention (Woldaregay et al., 2018). Resultingly, user engagement may positively impact treatment effectiveness, which translates to both reduced symptomatology and enhanced wellbeing (Cowpertwait & Clarke, 2013; Johnson & Wardle, 2011; Richardson et al., 2013). Therefore, it may be stated that the experience of user engagement is crucial for effective web-based interventions. What has yet to be established, however, are practical ways in which user engagement may be enhanced to increase uptake and adherence rates, and thereby treatment effectiveness.

Enhanced user engagement may partially be achieved through increasing perceived system usability (Nitsch et al., 2016; O'Brien & Toms, 2008; O'Brien, Toms, Kelloway, & Kelley, 2008). Perceived system usability refers to the effectiveness and efficiency of an eMental Health technology, and the satisfaction the user derives in reaching a certain goal with help of the eMental Health technology (Brooke, 1986; Stark et al., 2015). Perceived system usability is conceptually different from user engagement, as it emphasizes on user performance with an eMental Health technology, rather than user experience (Bevan, 2009; O'Brien, Toms, Kelloway, & Kelley, 2008). Similar to user engagement, perceived system usability was found to positively relate to uptake and adherence rates, as well as treatment effectiveness (Graaf et al., 2013; Stark et al., 2015; Stjernswärd & Hansson, 2016) Therefore, identifying what aspects of eMental Health technologies influence user engagement and perceived system usability may be valuable in improving the treatment and prevention of a variety of complaints.

A possible, but understudied method to enhance user engagement and perceived system usability in web-based interventions involves tailoring (Schubart, Stuckey, Ganeshamoorthy, & Sciamanna, 2011). Tailoring includes the adaption of health messages, including user-references, informational content, and feedback to the users' psychological characteristics (Wangberg, Nilsen, Antypas, & Gram, 2011). The tailoring-process is often conducted in accordance with evidence-based models on (changes in) human behaviour (e.g. Lustria, Cortese, Noar, & Glueckauf, 2009). A limited amount of meta-analyses indicate that web-based interventions which tailor health messages based on such models know greater positive evaluations by users, enhance attention and engagement in users, and provide greater benefits on the users' health and wellbeing (Lustria et al., 2009; Lustria et al., 2013). As such, tailoring could be valuable in the development of successful web-based interventions. Nevertheless, it is believed that the current approach to tailoring is limited. Tailoring is mainly applied to the content (i.e. health messages) of web-based interventions, whereas tailoring of the design often remains unaddressed (e.g. Lustria et al., 2009; Wangberg et al., 2011). Possibly, including design-changes in the tailoring-process may proof fruitful in enhancing user-experiences with web-based interventions. In particular, it is cerebrated whether the latter may occur by individual differences in visual sensory processing.

Before the relationship between individual differences in visual sensory processing and user-experiences with web-based interventions may be addressed, it is valuable to gain an understanding of what sensory processing entails. Sensory processing may be defined as the natural capacity of the central nervous system to identify, connect, and respond to multimodal sensory information (Davies & Gawin, 2007; Shimizu, Bueno, & Miranda, 2014). The sensory modalities involved in sensory processing are taste, smell, movement, hearing, vision, touch, and activity level (Augstein & Neumayr, 2019; Brown & Dunn, 2002). In regard to web-based interventions, vision (e.g. images; colouring) is believed to be most prominent. Individual differences exist in the sensitivity with which the nervous system processes sensory information (Davies & Gawin, 2007). Specifically, individuals may experience either hyposensitivity (i.e. understimulation) or hypersensitivity (i.e. overstimulation) to sensory stimulation (Koziol, Budding, & Chidekel, 2011). Hypo- and hypersensitivity may bring forth individual differences in the preferences of, and responses to sensory stimulation (Brown & Dunn, 2002; Dunn, 1997). Perhaps such individual differences may exist in regard to the observance of, and interaction with visual stimuli over web-based interventions as well. Hence it is valuable to gain an understanding of what the individual differences entail, and how they could be addressed in tailoring the design of web-based interventions.

For enhanced knowledge on individual differences in sensory processing, Dunn's (1997) Model of Sensory Processing may be used. According to Dunn (1997), sensory processing involves two interacting principles which determine behaviour; neurological thresholds (hyposensitivity/hypersensitivity), and behavioural responses (active/passive) (Crane, Goddard, & Pring, 2009). Depending on the interaction between principles, one is categorised under four profiles. In specific, hyposensitive individuals either passively process sensory stimuli less effectively (Low Registration), or actively search for greater sensory stimulation to counter sensory deprivation (Sensation-seeking). Contrarily, hypersensitive individuals either passively experience greater sensory stimulation as uncomfortable (Sensory Sensitivity), or actively try to reduce sensory stimulation to avoid discomfort (Sensation-avoiding) (Brown et al., 2001; Crane et al., 2009; Dunn, 1997). The model brings forth implications for user-experiences with web-based interventions. Particularly, the model implies that hyposensitive individuals are more likely to prefer and/or engage with highly visually stimulating web-based interventions while avoiding lesser stimulating ones, whereas hypersensitive individuals would display direct opposite preferences and responses. Nevertheless, multiple studies complicate these implications, as sensory processing could be further influenced by a range of factors.

Personality traits and psychological states may impact the preferences of, and responses to sensory stimulation in individuals, regardless of their initial categorisation as being hypo- or hypersensitive. Firstly, studies on personality traits found that hypersensitive individuals who show high levels of introversion, neuroticism, and shyness are more likely to experience negative affect in regard to greater sensory stimulation. In contrast, individuals who show high levels of extraversion and openness to experience may be more likely to experience positive affect (Aron & Aron, 1997; Sobocko & Zelinski, 2015). Concerning psychological states, studies found that individuals who suffer from mental difficulties such as stress, anxiety, and depression are prone to experience enhanced hypersensitivity (Bakker & Moulding, 2012; Brindle, Moulding, Bakker, & Nedeljkovic, 2015). The findings indicate that each user should be identified as unique in the tailoring-process, meaning that design-options ought to match the exact needs and wishes of each user. The question remains, then, how one may tailor the design of web-based interventions to individual user-needs and wishes.

Studies exist on the development of websites that could form a basis for the tailoring-process of web-based interventions, so that individual differences in sensory processing may be accounted for. Namely, a meta-analysis by Garett, Chiu, Zhang and Young (2016) summarises seven key design-elements that may be used to increase the user engagement with, and perceived system usability of websites (Garett et al., 2016). The design-elements include the ease of navigation through the website, the quality and quantity of graphical representations, an adequate organisation of contents, the perceived utility of a website, the fittingness and uniqueness of the purpose of the website, the simplicity of design, and the readability of content (Garett et al., 2016). Furthermore, Garett and others (2016) established practical ways to include the design-elements into websites. For example, the authors state that graphical representations should contain adequate size and resolution, different colour palettes, be visually attractive, and provide space for blank surroundings. Although the aforementioned findings are highly valuable, they seemingly imply that the tailoring-process of design-aspects knows a one-size-fits-all approach. However, based on the information on sensory processing, the tailoring-process ought to account for the experience of hypo- and hyposensitivity, as well as differences in personality traits and psychological states to create an optimal fit for each user.

As may be concluded from the above-mentioned findings, there is a need for research that further unravels the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions. As such, the present study is believed to be the first to address the expected user engagement with, and perceived system usability of web-based interventions in University students in light of individual differences in visual sensory processing. To achieve this, the present study utilised four web-based interventions provided by the eHealth platforms *MindDistrict* (n.D.) and *TherapieLand* (n.D.) which were paired based on topic (i.e. nutrition; relaxation). Important to note, is that the present study forms a predecessor to future studies due to limitations by the ongoing pandemic. The future studies shall use open interviews and eye-tracking techniques to evaluate the above-mentioned relationship, rather than an online questionnaire. The study questions for the present study include:

(1) '*To what extent are the final ratings of the eHealth platforms and scores on the four quadrants of Dunn related?*'

(2) '*In how far are the visual sensory appeal of visual stimuli in the web-based interventions and scores on the four quadrants of Dunn related?'*

(3) '*To what extent are users' expected engagement with the eHealth Platforms and scores on the four quadrants of Dunn related?'*

(4) '*To what degree are users' perceived system usability of the eHealth Platforms and scores on the four quadrants of Dunn related?'*

(5) '*What design-elements do participants value in their experience of web-based interventions?'.*

(6*) 'How do participants perceive the attractiveness of visual stimuli presented in the web-based interventions?'.*

Methods

Participants

Participants had to meet two inclusion criteria. Namely, participants must (1) study at a University, and (2) be aged eighteen or above. Participants were recruited based on a convenience sampling procedure through personal (social media) networks, and Sona-Systems (n.D.). Sona-Systems is a software programme that allows university students to partake in research in order to receive study credits.

In total, 57 participants were recruited. Herein, 38 participants were obtained through personal (social media) networks, and 19 participants through Sona-Systems. Regarding exclusions, 12 participants were removed due to missing responses on the TWEETS and/or SUS. The resulting dataset included 45 participants with a mean age of 22 (*SD* = 2.03), ranging from 19 to 27. The sample included 29 females, and 16 males.

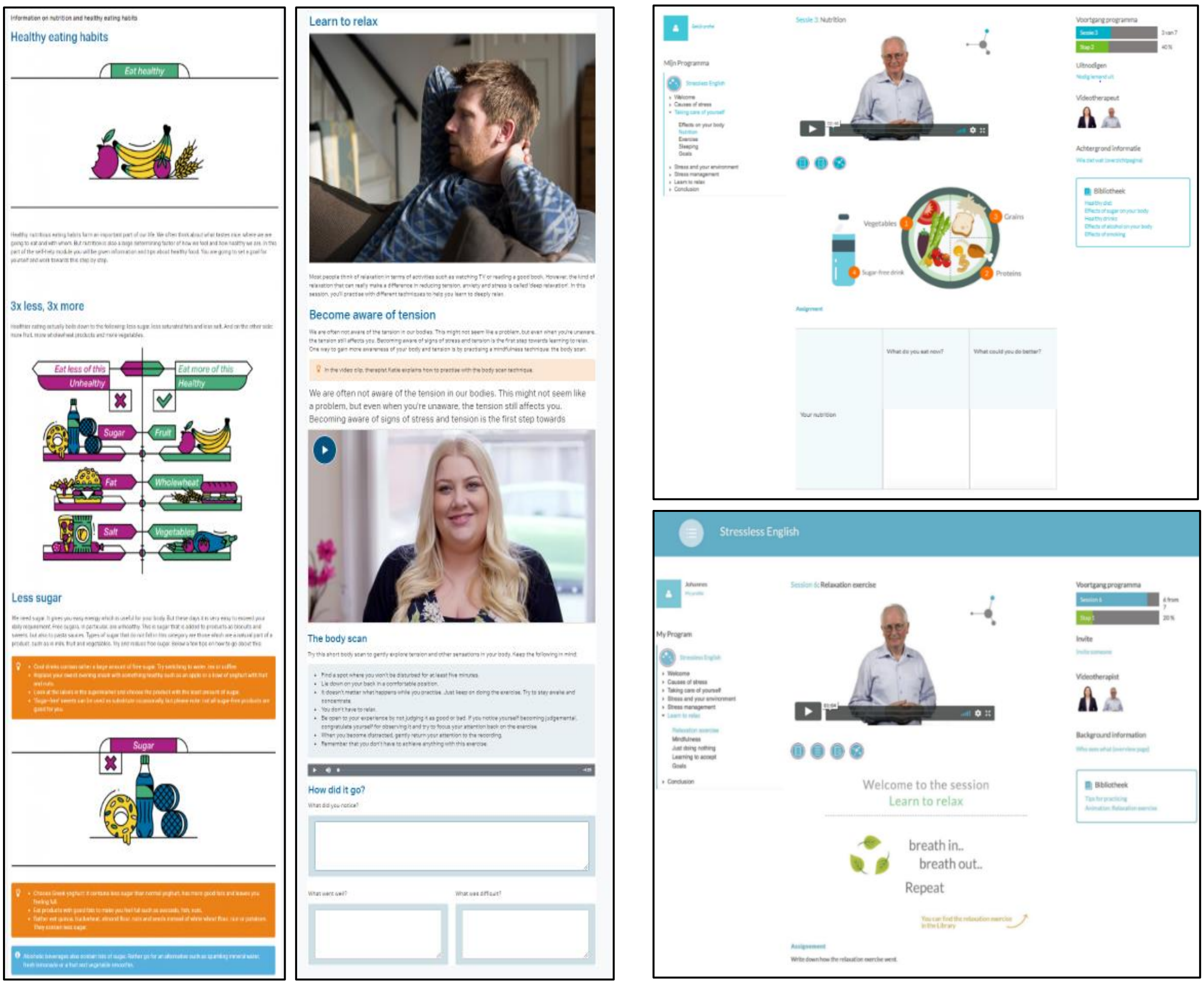

Figure 1. Screenshots of the web-based interventions 'Nutrition' and 'Relaxation' in MindDistrict (left) and TherapieLand (right).

Materials

Ethical approval for the present study was granted by the Ethics Committee of Behavioural, Management and Social sciences (BMS) at the University of Twente (approval code: 200654). The present study deployed a cross-sectional survey design. Participants were asked to fill in an online questionnaire.

Permission was granted by *MindDistrict* and *TherapieLand* to include two web-based interventions per eHealth platform in the questionnaire. The present study selected the web-based interventions based on similarity in topics. Specifically, these topics were 'nutrition' and 'relaxation'. For the topic 'nutrition', the web-based interventions 'Healthy Eating Habits' in *MindDistrict* and 'Nutrition' in *TherapieLand* were used. For the topic 'relaxation', the present study included the web-based interventions 'Learn To Relax' in *MindDistrict,* and 'Relaxation exercise' in *TherapieLand*. For ease of reading, the present study shall refer to the web-based interventions by using the names of topics (i.e. nutrition; relaxation).

Both eHealth platforms make use of modules, of which the topics are based on a difficulty users may experience or a goal they tempt to reach (e.g. stress; healthy lifestyle). Modules include an amount of web-based interventions concerning different sub-topics. To illustrate, modules that focus on improving one's lifestyle may involve web-based interventions surrounding healthy nutrition, engaging in exercise, and improving one's sleeping patterns. In turn, the web-based interventions provide users with educational information. The educational information is conveyed through text, drawn images, photos, videos, and assignments (see Figure 1; enlarged versions are found in Appendix 1 and 2).

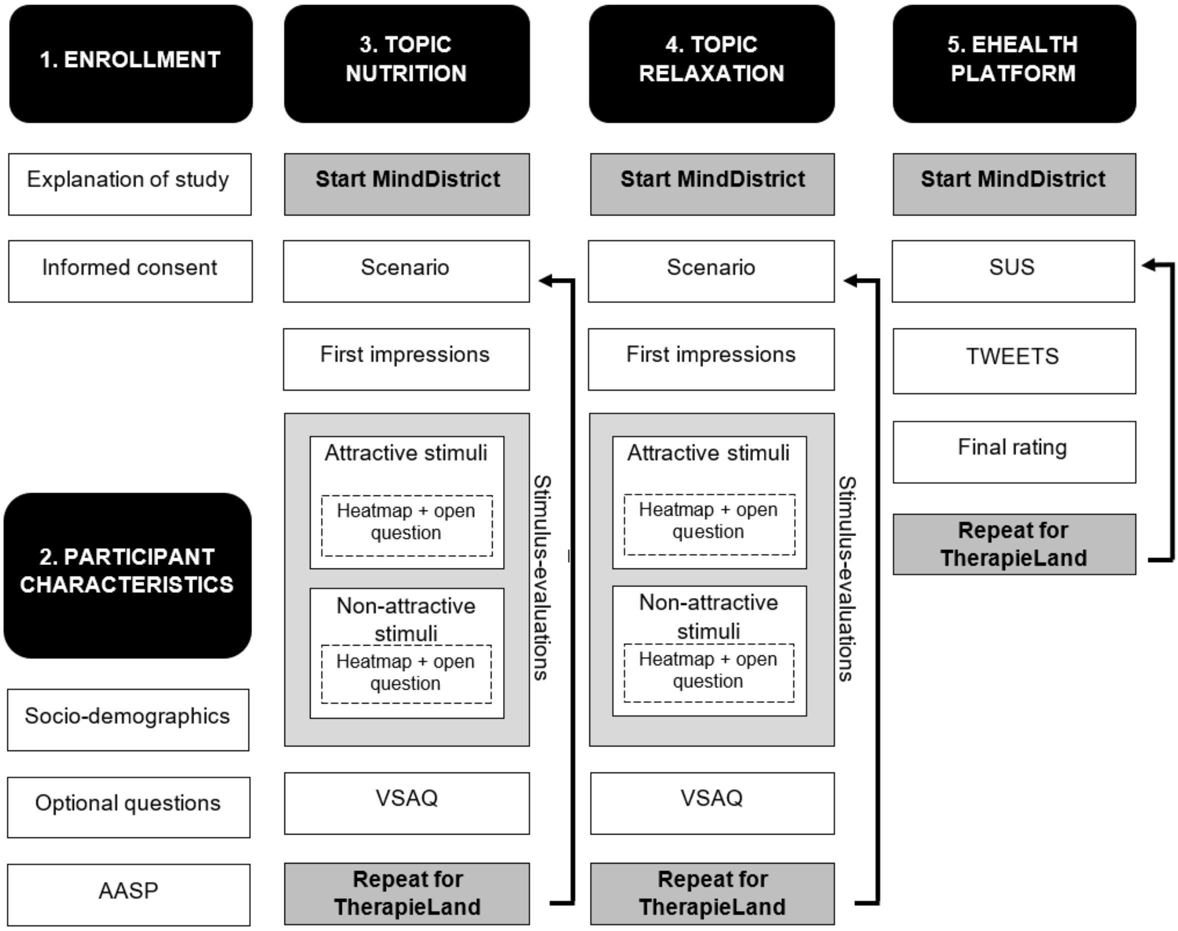

Figure 2. Procedure of the present study.

Procedure

The questionnaire was developed in, and published over Qualtrics. The questionnaire took 30 minutes to fill out, respectively. Participants were required to finish the questionnaire over the span of a month. The participant was provided with an informed consent, to which they had to agree in order to participate in the present study. Afterwards, participants filled in the following measures. The measures are structured based on their placement in the questionnaire. An overview of the procedure for the present study may be found in Figure 2.

Socio-demographics. Questions on socio-demographics included: age, gender, nationality, location of studies, and study course.

Optional questions. The optional questions included: unspecified diagnoses of neurodevelopmental, neurological and/or psychological conditions, and use of medications that may affect sensory processing sensitivity and/or ability.

Adolescent/Adult Sensory Profile (AASP). The AASP (Brown & Dunn, 2002) is a self-report questionnaire that allows for the measurement of individual differences in visual sensory processing. The AASP originates from Dunn's (1997) Model of Sensory Processing, and is based on its child-version (Sensory Profile; SP). The AASP contains 60 items related to the seven sensory modalities: taste, smell, movement, hearing, vision, touch, and activity level. The items are answered on a five-point Likert scale ranging from 'Almost never' to 'Almost always'. Items are grouped along four quadrants, including (Q1) Low Registration, (Q2) Sensation-seeking, (Q3) Sensory Sensitivity, and (Q4) Sensation-avoiding. Notably, scores on the quadrants may also be calculated for individuals based on single sensory modalities. As such, the present study shall make use of the quadrant-scores for the AASP in its entirety, and the quadrant-scores for the visual modality-related questions of the AASP (see: AASP-Visual Modality; AASP-VM). Unfortunately, the present study found that questions for the sensory modality 'smell' were removed while implementing the questionnaire in Qualtrics. Consequently, the present study could not compare the sample scores with norm groups. It is advised to interpret scores on the AASP with caution. Finally, the psychometric properties of the AASP were found to be satisfactory. The AASP shows sufficient internal consistency, item reliability, inter-rater reliability, and test-retest reliability, as well as sufficient construct validity, and convergent and divergent validity (Brown et al., 2001; Chung, 2006; Engel-Yeger, 2012).

Scenarios. Scenarios were created that had to be read by participants prior to the evaluation of web-based interventions. The scenarios were used to provide participants with a reason as to why they would utilise the web-based interventions. The scenarios were written from a 'you'-perspective, and standardised in lay-out. Regarding the latter, the participant was first provided with health information retrieved from the Internet (i.e. healthy diet/relaxation improves well-being), after which the participant was given a fictional life goal that could be achieved by using the web-based interventions (i.e. improve food intake; learn relaxation strategies). The scenarios are found in Appendix 3.

First impressions. Screenshots were shown of individual web-based interventions. Participants were asked to observe the screenshots, and to share their first impressions of the web-based interventions through an open question. The screenshots are found in Figure 1, whereas enlarged versions may be found in Appendix 1 and 2.

Heatmaps. Screenshots were shown twice of each web-based intervention. Herein, participants had to select up to three properties of visual stimuli the participant deemed to be

(1) attention-grabbing and attractive, or (2) attention-grabbing and non-attractive by left-clicking on their locations. Participants had the opportunity not to select any properties.

Stimulus-evaluations. Participants were asked to name the selected visual stimuli in the screenshots of the given web-based intervention, whereafter they were requested to share their evaluation of the visual stimulus (see: stimulus-evaluation). Stimulus-evaluations were requested through an open question. Specifically, participants were asked to elaborate on: (1) properties of visual stimuli that were attention-grabbing and attractive, and (2) properties of visual stimuli that were attention-grabbing and non-attractive. Participants had the opportunity not to respond to the questions.

Visual Sensory Appeal Questionnaire (VSAQ). The Visual Sensory Appeal Questionnaire (VSAQ) is a self-developed measure used to evaluate the extent to which participants find the levels of sensory stimulation provided by visual stimuli appealing. The VSAQ was created by deducting key terms from the AASP (Brown & Dunn, 2002) which formed semantic opposites, and placing these on a bipolar scale. Resultingly, four five-point bipolar scales were created that make up the questionnaire. The scales contain the bipolar terms: (a) ‘messy’ or ‘well-structured’, (b)‘overwhelming’ or ‘endurable/tolerable’, (c) ‘distracting’ or ‘calm’, and (d) ‘not enjoyable’ to ‘very enjoyable’. Scores on the VSAQ range from four to 20. Higher scores indicate greater appeal of the provided visual stimulus, whereas lower scores indicate lesser appeal. To end, psychometric properties of the VSAQ have yet to be tested as the scale was newly developed. Nevertheless, the present study did find high internal consistency of the VSAQ, as identified with a Cronbach’s alpha of .858 for *MindDistrict*, and .871 for *TherapieLand*.

TWente Engagement with Ehealth Technologies Scale (TWEETS). The TWente Engagement with Ehealth Technologies Scale (TWEETS) (Kelders & Kip, 2019) was used to measure expected user engagement with eHealth technologies. The TWEETS contains three components; behavioural engagement, cognitive engagement, and affective engagement. Each component contains three questions, which are answered on a five-point Likert scale. Final scores range from zero to 36. Higher scores indicate greater engagement with the eHealth technology. Lastly, the psychometric properties of the TWEETS were found to be satisfactory (Kelders & Kip, 2019).

System Usability Scale (SUS). The System Usability Scale (SUS) (Brooke, 1986) may be used to assess the system usability of (eMental Health) technologies. To achieve this, the SUS makes use of ten items on a five-point Likert scale. The scale contains three factors; the effectiveness of a system, the efficiency of a system, and user-satisfaction. Final scores range from zero to 100, with higher scores indicating greater perceived system usability of a system (Brooke, 1986). the wording of the SUS was adjusted to measure perceived system usability, rather than actual system usability. Finally, the psychometric properties of the SUS show to be acceptable. Studies identified that the SUS has satisfactory internal consistency and test-retest reliability, as well as satisfactory internal validity and convergent validity (Dianat, Ghanbari, & Asghari-Jafarabadi, 2014; Martins et al., 2015).

Final rating. The final rating of eHealth platforms was provided on a ten-point scale. Lower scores indicate participants to have lesser interest in the eHealth platform, whereas higher scores indicate greater interest.

Data analysis

The present study utilised IBM SPSS Statistics 26 for quantitative analyses, and Excel and Atlas.ti 8 for qualitative analyses. To start, descriptive statistics were used to establish sample characteristics. Followingly, mean scores on the quadrants were calculated for the AASP, as well as the AASP-VM. Normality was tested for the AASP-quadrant scores with Kolmogorov-Smirnov and Shapiro-Wilk tests. The Kolmogorov-Smirnov test indicated scores on the scale ‘Low Registration’ not to be normally distributed (p = .001). The non-normality of scores was found to be negligible as findings were non-exclusive. Thereafter, mean scores were established for the other variables, including; visual sensory appeal (VSAQ), expected user engagement (TWEETS), perceived system usability (SUS), and the final rating of eHealth platforms.

Correlations. To answer the first four study questions, multiple Pearson correlations were conducted. In specific, the present study tempted to identify the relationships between scores on the AASP-quadrants and AASP-VM-quadrants with the other variables. The strength of correlational coefficients was determined based on the guidelines established by Frost (2020). That is, correlations below .6 were labelled as weak, correlations between .6 and .8 as moderate, and correlations above .8 as strong.

Inductive content analyses. To answer the fifth and sixth study question, the present study employed inductive content analyses alongside heatmaps. Inductive content analyses involve the identification of patterns in participant responses, in which themes are derived directly from the data. Specifically, participants’ first impressions were used to identify what design-elements participants value in their experience of web-based interventions (study question 5). Participants' stimulus-evaluations were used to evaluate what properties of visual stimuli enhance or decrease their perceived attractiveness (study question 6). To accomplish this, the following was done for each study question, and for each web-based intervention.

Firstly, the present study imported participant responses into Excel. Herein, the present study identified participant responses that were uninterpretable (i.e. major spelling/grammar errors; missing explanations) and/or inappropriate (i.e. unrelated to first impressions or stimulus-evaluations) for exclusion. The excluded participant responses were grouped under the labels 'unidentifiable' and 'irrelevant', and moved to a second Excel-file.

Secondly, the present study tempted to derive higher-order themes (or coding categories) from participant responses. To start, the participant responses were imported in Atlas ti.8. Followingly, participant responses were summarised in a note connected to each response. Then, the notes were read through in order to establish coding categories. After the creation of coding categories, revisions were done by reading through the notes again.

Thirdly, the present study aimed to establish lower-order themes (or codes) from participant responses. To accomplish this, the notes connected to the participant responses were re-read, and the responses that showed an overlap in content were grouped. After all participant responses were grouped, codes were created that summarised the content of the grouped responses. Followingly, revisions were done by establishing whether the notes matched their codes. To end, a final revision of all coding categories and codes was done.

Lastly, the heatmaps were used (Appendix 5 to 8). Notably, all areas on the heatmap that displayed visual stimuli (i.e. image; video) were labelled as an Area Of Interest (AOI). The present study used the heatmaps to analyse findings from participants' stimulus-evaluations in-depth. Specifically, the heatmaps allowed the present study to identify exact locations within AOIs that were frequently selected by participants. The present study compared the selected areas on the heatmaps with the codes and notes from the inductive content analyses. The comparison was done to establish whether the heatmaps provided insights that did not become directly apparent through the codes and notes.

Results

Participant characteristics

Participants had a mean age of 22.1 (*SD* = 2.03), ranging from 19 to 27. The sample included 64% females (*n* = 29), and 36% males (*n* = 16). Regarding nationality, 73% of the sample was German (*n* = 33), 7% was Dutch (*n* = 3), and 20% was born in another country (*n* = 9). Furthermore, 73% of the participants studied at the University of Twente (*n* = 33), whereas 27% studied at another University (*n* = 12). Specifically, 20 participants (44%) indicated to be Psychology students, nine participants (20%) were Communication Science students, and 16 participants (36%) followed another study programme. The optional questions included 44 responses, as one participant preferred not to answer. One participant (2%) was diagnosed with (a) neurological and/or neurodevelopmental disorder(s), and three participants (7%) were diagnosed with (a) psychological disorder(s). Two participants (4%) made use of medications that may affect sensory processing ability and/or sensitivity, of which one participant experienced one of the abovementioned disorder(s).

Table 1

Means, Minimum Scores, Maximum Scores, and Standard Deviations of the sample on the AASP- and AASP-VM-quadrants

	M	*Min*	*Max*	*SD*
AASP-quadrants				
Q1	26.80	14.00	41.00	7.05
Q2	41.07	28.00	52.00	5.84
Q3	33.27	20.00	48.00	7.52
Q4	30.18	19.00	44.00	6.28
AASP-VM-quadrants				
Q1	3.73	2.00	7.00	1.47
Q2	6.89	4.00	10.00	1.37
Q3	7.38	3.00	13.00	2.53
Q4	7.71	3.00	13.00	1.98

Note. *N* = 45. AASP = Adolescent Adult Sensory Profile. AASP-VM = Adolescent Adult Sensory Profile – Visual Modality. Q1 = Low Registration. Q2 = Sensation-seeking. Q3 = Sensory Sensitivity. Q4 = Sensation-avoiding.

Scores on AASP- and AASP-VM-quadrants

Mean scores on the AASP- and AASP-VM-quadrants are found in Table 1. Findings for the AASP-quadrants include that Sensation-seeking; indicative of hyposensitivity, knows the highest mean score and the least amount of variance within the present sample. Contrarily, for the AASP-VM-quadrants, the highest mean score was found for Sensation-avoiding; indicative of hypersensitivity. The lowest mean scores were identified for Low Registration; indicative of hyposensitivity, for both the AASP- and AASP-VM-quadrants.

Scores on other variables

Mean scores on the other variables are found in Table 2. As may be observed, mean scores on all measures for *TherapieLand* show to be higher, whereas most of the standard deviations are lower. As a result of this observation, multiple one sample t-tests were conducted to evaluate whether a statistically significant difference existed between the mean VSAQ, TWEETS, and SUS-scores, and the mean final ratings for *MindDistrict* and *TherapieLand*. A significant difference was found for all measures; $t(44) \geq 12{,}291$, $p \leq 0.001$. In other words, the eHealth platform *TherapieLand* scored significantly higher in terms of visual sensory appeal, expected user engagement, perceived system usability, and the final rating than the eHealth platform *MindDistrict*.

Table 2

Means and Standard Deviations of the sample on the Final Rating, VSAQ, TWEETS, and SUS

	MindDistrict	TherapieLand
Final rating	5.42 (1.94)	6.69 (1.92)
VSAQ	12.04 (2.64)	14.84 (3.55)
TWEETS		
Behavioural	6.02 (3.06)	7.40 (2.61)
Cognitive	5.93 (3.57)	7.16 (2.84)
Affective	5.24 (3.64)	7.11 (3.05)
Total score	17.2 (9.39)	21.67 (7.67)
SUS		
Learnability	16.56 (4.21)	16.67 (4.52)
Usability	43.61 (16.05)	53.83 (17.61)
Total score	60.17 (17.90)	70.50 (17.61)

Note. *N* = 45. VSAQ = visual sensory appeal. TWEETS = expected user engagement. SUS = perceived system usability. Standard deviations are provided in parentheses.

Final rating

Multiple Pearson Correlations were used to determine whether there exists a relationship between the final rating of the eHealth platforms *MindDistrict* and *TherapieLand*, and scores on the AASP- and AASP-VM-quadrants. Correlation coefficients and probabilities of the final ratings with the AASP- and AASP-VM-quadrants can be found in Table 3. For the AASP-quadrants Low Registration and Sensation-seeking; indicative of hyposensitivity, significant but weak negative correlations were found with the final rating of *MindDistrict*. All other correlations were found to be insignificant, weak, and inconsistent in their direction.

Visual sensory appeal

Two of the 32 correlations were found to be significant (Table 3). These indicated weak negative relationships to exist between the VSAQ for the web-based intervention ‘Nutrition’ in *MindDistrict* with the AASP- and AASP-VM-quadrant Sensory Sensitivity; indicative of hypersensitivity. The other correlational coefficients show to be insignificant, weak, and inconsistent in their direction.

Expected user engagement

All correlations were found to be insignificant, weak and inconsistent in their direction (Table 3). The negative relationship between the AASP-quadrant Sensation-seeking; indicative of hyposensitivity, and the users’ expected engagement with *MindDistrict* did show to near a significant probability value.

Perceived system usability

All correlations were found to be insignificant, weak, and inconsistent in their direction (Table 3).

Table 3

Correlations between the AASP- and AASP-VM-quadrants with the Final Rating, VSAQ, TWEETS, and SUS

	AASP-quadrants				AASP-VM-quadrants			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Final rating								
MindDistrict	-.358*	-.362*	.014	.046	-.247	-.016	.110	.109
TherapieLand	-.022	-.016	-.040	.112	-.038	.004	.006	-.108
VSAQ								
MindDistrict - N	-.159	-.229	-.302*	-.234	-.147	-.142	-.362*	-.162
TherapieLand - N	-.093	.070	.001	.005	-.010	.026	.195	-.088
MindDistrict - R	-.166	-.094	.133	-.025	-.158	.184	.121	.111
TherapieLand - R	.077	.092	.032	.082	.110	.006	.105	-.085
TWEETS								
MindDistrict	-.059	-.275	.175	.039	.019	.224	.195	.043
TherapieLand	.028	.162	.020	.035	.069	.185	.070	-.175
SUS								
MindDistrict	-.206	-.247	.041	.050	-.212	.121	-.001	.070
TherapieLand	-.124	-.017	-.059	.054	-.102	-.074	.039	-.055

Note. *N* = 45. AASP = Adolescent Adult Sensory Profile. AASP-VM = Adolescent Adult Sensory Profile – Visual Modality. Q1 = Low Registration. Q2 = Sensation-seeking. Q3 = Sensory Sensitivity. Q4 = Sensation-avoiding. N = web-based intervention ‘Nutrition’. R = web-based intervention ‘Relaxation’. VSAQ = visual sensory appeal. TWEETS = expected user engagement. SUS = perceived system usability.
Note. *p < 0.05. **p < 0.01. ***p < 0.001.

Participant evaluations of eHealth Platforms

The present study established coding schemes for all four web-based interventions (Appendix 4). Herein, the present study extracted three coding categories in first impressions and stimulus-evaluations from the data. For participants' first impressions, the coding categories are: (1) Valence, or the nature of the participant's first impression being either positive or negative; (2) Design-element, or the valued visual element in a web-based intervention; and (3) Practical application, or a practical guideline as to how the design-element may be included in web-based interventions. For participants' stimulus-evaluations, coding categories are: (a) Stimulus-type, referring to the type of visual stimulus that was addressed by participants; (b) Attractiveness, or the perception of a visual stimulus as being either attractive or non-attractive ; and (c) Property, or the specific aspect of a visual stimulus that enhances or decreases perceived attractiveness. Ultimately, summaries of findings for the participants' first impressions and stimulus-evaluations were created. The summaries were created to connect findings from the individual web-based interventions, and to support ease of reading. Findings from the summaries include the following.

First impressions

Participants' first impressions were used to identify the valued design-elements by participants in their experience of web-based interventions (Table 4). Herein, findings of all web-based interventions were combined. Moreover, the design-elements are ordered from high to low in frequency of mentions.

The most frequently-mentioned design-elements were found to include: [1] simplicity (60%), or the use of a clean design with little text and distractive visual stimuli, and the containment of a clear structure; [2] colouring (17%), or the use of an attention-grabbing and enjoyable colour palette, the non-use of too many colours, and the creation of contrast; [3] visuals (14%), or the use of visual stimuli that are pleasing to the eye, attention-grabbing, and of adequate size, which may support in understanding the content of web-based interventions, and know different stimulus-types (e.g. image, video); [4] readability (4%), or the use of readable fonts which know adequate text size and colouring; and [5] scaling (1%), or the use of adequate sizes between stimuli.

Table 4

Summary of First Impressions

Design-element	Practical application
Simplicity (60%)	- Contains a clean design
	- Contains little text
	- Contains little distractive visual stimuli
	- Contains a clear structure
Colouring (17%)	- Uses an attention-grabbing and enjoyable colour palette
	- Does not use too many colours
	- Allows for the creation of contrast between visual stimuli
Visuals (14%)	- Perceived as pleasing to the eye
	- Perceived as attention-grabbing
	- Knows adequate sizing
	- Supports in understanding the content
	- Includes different stimulus-types
Readability (4%)	- Uses readable text fonts
	- Knows adequate text sizing and colouring
Scaling (1%)	- Contains adequate sizing between visual stimuli

Note. Frequency of selections is presented in parentheses. The percentages were calculated by dividing the amount of quotations in the codes by all possible quotations (i.e. three times the amount of participants). Left-over percentages involve non-response, and the codes 'Irrelevant' and 'Unidentifiable'

Stimulus-evaluations

Participants' stimulus-evaluations were used alongside heatmaps to identify how participants perceived the attractiveness of visual stimuli presented in the web-based interventions of each eHealth platform, and what properties contributed to their perceived attractiveness (Table 5). In this table, findings were split between the eHealth platforms. Furthermore, the stimulus-types are ordered based on frequency of mentions as containing attractive or non-attractive properties.

The most-to-least attractive visual stimuli for *MindDistrict* were: titles (7% over 0%), exercises (16% over 4%), videos (16% over 7%), blue tabs (11% over 8%), images (45% over 44%), orange tabs (8% over 11%), and black-on-white texts (0% over 3%). For *TherapieLand*, these included: images (47% over 6%), videos (22% over 7%), exercises (13% over 12%), additional info-boxes (8% over 13%), and programmes (5% over 14%).

Direct comparisons between findings for *MindDistrict* and *TherapieLand* were made as both eHealth platforms contained images, videos and exercises. Firstly, images were selected most commonly for both eHealth platforms. In specific, images in *MindDistrict* (45%

over 44%) were judged to be more evenly divided in containing attractive and non-attractive properties, whereas those in *TherapieLand* (47% over 6%) were evaluated as containing predominantly attractive properties. Descriptions for the attractive and non-attractive properties of images showed to differ for the eHealth Platforms. The difference in descriptions regarded participants' experiences of the colouring.

Secondly, videos were found to be selected more commonly as containing attractive than non-attractive properties for both *MindDistrict* (16% over 7%) and *TherapieLand* (22% over 7%), albeit that the frequency of selections of attractive properties for videos in *TherapieLand* was slightly higher. The mentioned properties by participants for videos in both eHealth platforms were near-equal. Namely, the videos in both eHealth platforms were judged based on their visuals and included presenter. Support in navigation was only mentioned for the videos in *TherapieLand*.

Lastly, exercises in *MindDistrict* (12% over 4%) were evaluated as containing more attractive than non-attractive properties, whereas those for images in *TherapieLand* were more evenly divided (13% over 12%). Descriptions for the attractive and non-attractive properties of exercises show to differ per eHealth platform. Specifically, this regarded participants' experiences of the visuals and colouring.

Table 5

Summary of Stimulus-evaluations for MindDistrict and TherapieLand

MindDistrict			
Attractive		Non-attractive	
Stimulus-type	Property	Stimulus-type	Property
Images (45%)	Know a minimalistic drawing style	**Images (44%)**	Know an unenjoyable drawing-style
	Contain a bright/diverse colour palette		Contain an unrealistic/bright colour palette
	Know an adequate size		Miss contrast
	Clearly contain important information		Contain too large sizes
	Contain little text		Are wrongfully positioned
	Are fitting to the topic		Person in image is negatively evaluated
	Person in image is positively evaluated	**Orange tabs (11%)**	Contain a too bright colour
Video (16%)	Contains attention-grabbing visuals		Contain too much text
	Presenter is positively evaluated		Contain too small text
Exercise (12%)	Contains attention-grabbing visuals	**Blue tabs (8%)**	Contain a too bright colour
	Contains a clear structure		Contain too much text
Blue tabs (11%)	Contain an enjoyable/attention-grabbing colour		Contain too small text
	Contain a clear structure	**Video (7%)**	Presenter is negatively evaluated
	Clearly contain important information	**Exercise (4%)**	Contains large and many textboxes
Orange tabs (8%)	Contain a bright colour		Knows an unclear use by missing explanation
	Clearly contain important information	**Black-on-white texts (3%)**	Contains too much text
Titles (7%)	Contain attention-grabbing visuals/colours		Is crowded between other stimulus-types

TherapieLand			
Attractive		Non-attractive	
Stimulus-type	Property	Stimulus-type	Property
Images (47%)	Contain a clear structure	**Programmes (14%)**	Contain too much information
	Contain attention-grabbing visuals/text		Form a distraction
	Contain natural, calming colour palettes		Presenter is negatively evaluated
	Contain an enjoyable drawing-style	**Add. info-boxes (13%)**	Form a distraction
	Provide visual support in learning		Contain a simplistic lay-out
	Enhance engagement		Contain an unenjoyable colour palette
	Are fitting to the topic		Contain a small size
Videos (22%)	Presenters are positively evaluated	**Exercises (12%)**	Lack of colour
	Contain attention-grabbing visuals		Contain an unclear structure
	Support in navigation		Contain unexciting visuals
Exercises (13%)	Contain a clear structure	**Videos (7%)**	Presenters are negatively evaluated
Add. Info-boxes (8%)	Contain attention-grabbing faces		Lack a background colour
	Contain attention-grabbing colours	**Images (6%)**	Are mispositioned
	Contain a clear structure		
Programmes (5%)	Clarify what information is available		
	Contain a clear structure		

Note. Frequency of selections is presented in parentheses. The percentages were calculated by dividing the amount of quotations in the codes by all possible quotations (i.e. three times the amount of participants). Left-over percentages involve non-response, and the codes 'Irrelevant' and 'Unidentifiable'.

Additional findings from heatmaps

This section provides cropped versions of the heatmaps to display the most valuable findings. The original heatmaps may be found in Appendix 5 to 8. AOIs in the original heatmaps were marked with letters. The letters correspond with those of the stimulus-types in the coding schemes for ease of identification (Appendix 4).

Firstly, the heatmaps revealed that the specificity with which attractive and non-attractive properties of images were selected differed per eHealth Platform (Figure 3). For *MindDistrict*, selections were found to be more dense in specific locations. To illustrate, the heatmap for the web-based intervention ‘Nutrition’ shows that the selection of attractive properties in the first image mainly regarded the banana, whereas the selection of non-attractive properties were focused on the apple and banana (Figure 3a). The same may be observed for the second image, since the bottle was selected mainly as including attractive properties, whereas the bottle, doughnuts and cross-mark were selected as including non-attractive properties (see Figure 3b). Contrarily, the selection of attractive and non-attractive properties of images in both web-based interventions of *TherapieLand* were found to be less specific, as the selected areas were centred in the middle of the image (Figure 3c; Figure 3d).

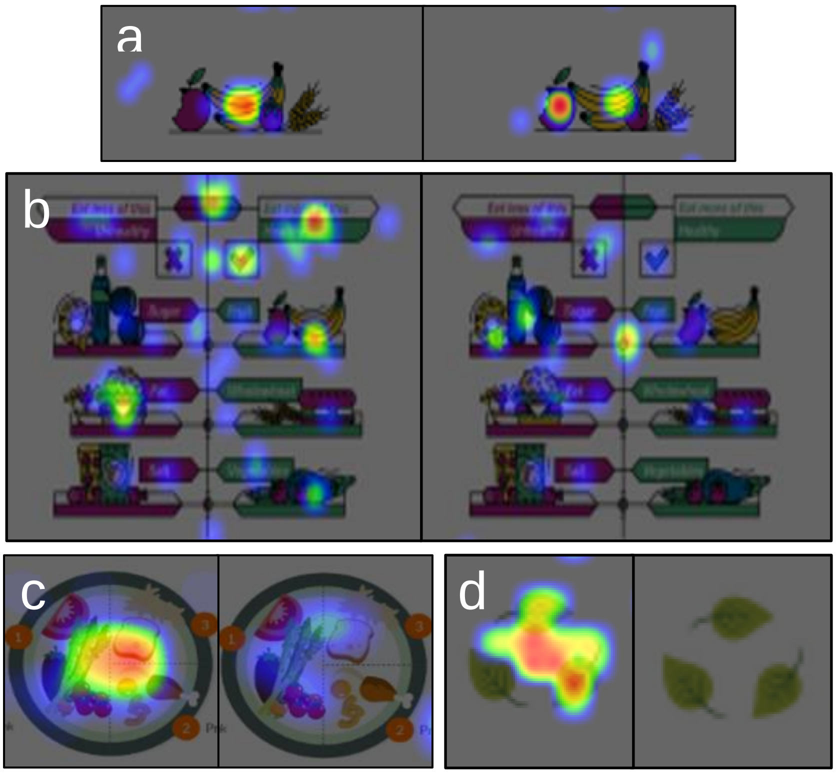

Figure 3. Heatmaps of the attractive (left) and non-attractive (right) properties of images in the eHealth platforms. The specificity of selections shows to be higher for images in MindDistrict (a; b) than those in TherapieLand (c; d).

Secondly, the heatmaps showcased a thorough focus of participants on humans and/or human faces in a range of visual stimuli provided over both eHealth platforms (Figure 4). For example, the heatmap for the image and video in the web-based intervention 'Relaxation' in *MindDistrict* shows that participants mainly selected the individuals' eyes and mouths as influencing perceived attractiveness. To add, participants emphasised on the positioning of the arms of the individual in the image (Figure 4a). Furthermore, for the videos in both web-based interventions in *TherapieLand*, heatmaps reveal an emphasis on the mouth and throat of the individual (Figure 4b; Figure 4c).

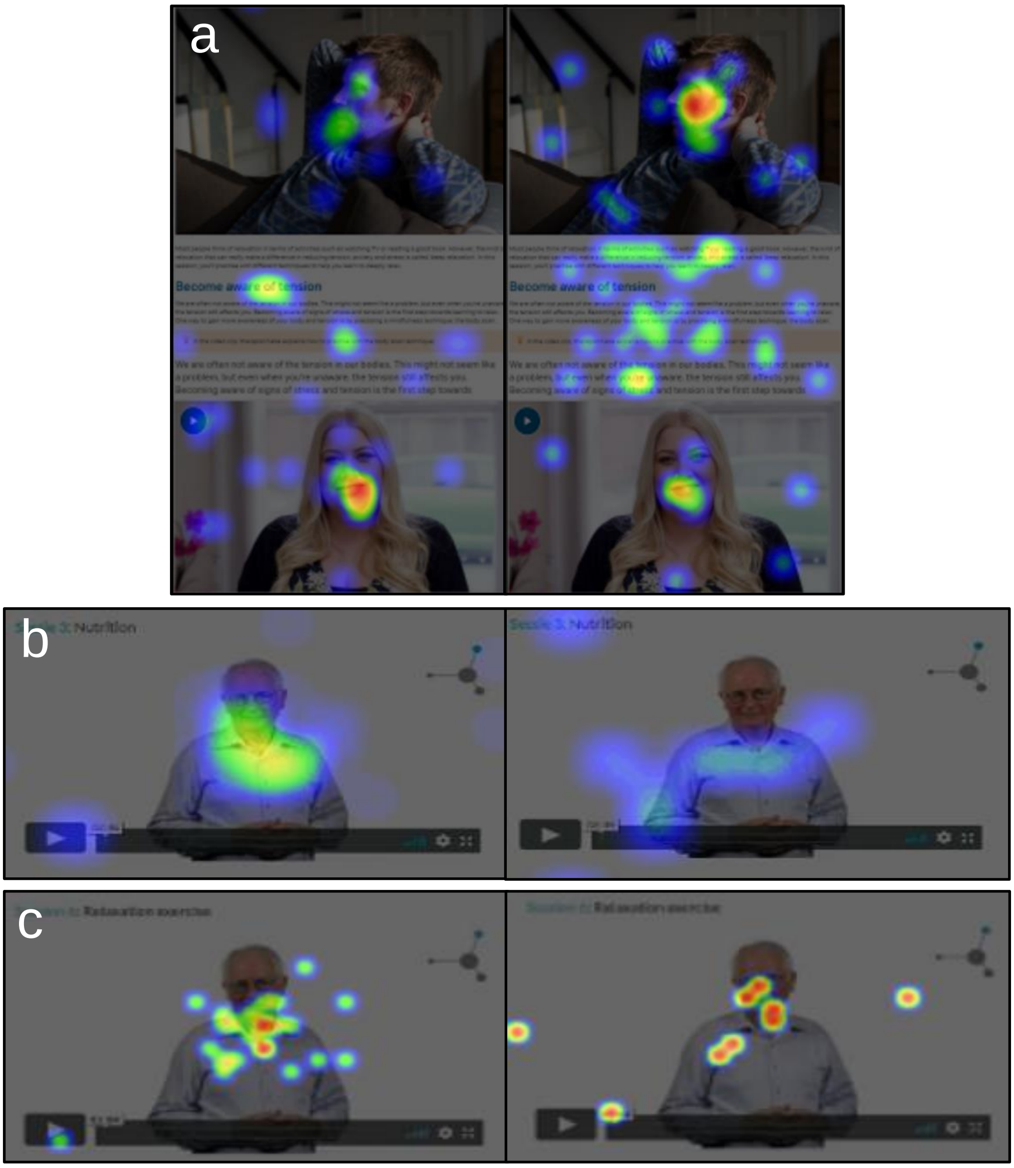

Figure 4. Heatmaps of the attractive (left) and non-attractive (right) properties of visual stimuli in the eHealth platforms. Participant selections indicate a thorough focus to exist on humans and/or human faces for both eHealth platforms.

Discussion

Main findings. The present study tempted to identify the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions by using a questionnaire that contained measures on visual sensory processing, expected user engagement, perceived system usability, a self-developed measure on visual sensory appeal, and a final rating of the eHealth platforms, as well as open questions on first impressions and the attractiveness of visual stimuli (or stimulus-evaluations). Four out of eighty correlations were found to be significant. Results demonstrated negative relationships to exist between hyposensitivity with the final ratings of *MindDistrict*, and (visual) hypersensitivity with the visual sensory appeal of *MindDistrict*. Regarding qualitative findings, the majority of participants were found to value the simplicity of designs. Moreover, differences were found in the selection of attractive and non-attractive properties of images. Participants also provided differential descriptions of their colouring.

Correlations. Insights into the relationships between visual sensory processing with final ratings and visual sensory appeal showed to be contradictory (study question 1; 2). Findings indicated that individuals who score higher in hyposensitivity rate their experience with *MindDistrict* less favourably than individuals with lower scores in hyposensitivity. In addition, it was found that individuals who score higher in hypersensitivity and visual hypersensitivity rate the visual sensory stimulation elicited by the web-based intervention 'Nutrition' in *MindDistrict* as less appealing than individuals who score lower in these domains. Only the latter finding was anticipated as a result of participants' descriptions of the web-based interventions and associated visual stimuli. For example, participants described the colouring of *MindDistrict* as diverse and bright, whereas the colouring of *TherapieLand* was stated to be natural and calming. Hence, *MindDistrict* was expected to be the more visually stimulating eHealth platform, which ought to be preferred by hyposensitive individuals according to a range of studies (e.g. Brown et al., 2001; Dunn, 1997).

Moreover, the present study could not find support for relationships to exist between visual sensory processing with expected user engagement and perceived system usability (study question 3; 4). Combined with the aforementioned contradiction between findings, this brings forth the question whether there may exist a relationship between individual differences in visual sensory processing and user-experiences of web-based interventions to begin with. Particularly, studies on sensory processing suggest that understimulation sensorially deprives hyposensitive individuals, whereas overstimulation causes discomfort in hypersensitive individuals (Crane et al., 2009; Dunn, 1997). Indications of such experiences were identified in the findings for stimulus-evaluations. Namely, participants frequently responded with terms such as ‘attention-grabbing’ and ‘distracting’; key terms for high stimulation, or ‘calming’ and ‘unexciting’; key terms for low stimulation, when evaluating the interventions and stimuli (Brown et al., 2001; Crane et al., 2009; Dunn, 1997). As such, the present study does encourage further exploration of the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions. However, adjustments ought to be made to the study setup so that currently experienced limitations may be avoided.

Design-elements. The design-elements found in the present study show extensive overlap with those from the meta-analysis on web design and user engagement by Garett and others (2017). To illustrate, the design-elements ‘readability’ and ‘simplicity’ were identified by both studies, and shared similar practical applications. Additionally, the design-elements ‘colouring’ and ‘visuals’, as found by the present study, showed to be represented under the unified label ‘graphical representations’ in the meta-analysis. The finding of overlap is valuable, as it implies that valued design-elements by users may be generalisable to an extent. In other words, utilising design-elements for the initial design of web-based interventions may accommodate for the needs and wishes of at least a proportion of users.

Nevertheless, the present study found a difference in regard to the frequency of mentions of the design-element ‘simplicity’. Namely, ‘simplicity’ was referred to in the vast majority of participant responses in the present study, whereas Garett and others (2017) found ‘simplicity’ to be amongst the lesser-mentioned design-elements. A possible explanation for this may be that a so-called ‘less is more’-principle accounts for both hypo- and hypersensitive individuals. That is, a reduction of visual distractions may be found valuable by all users of web-based interventions as it supports, for example, ease of navigation or quick information-gathering. Future studies may focus on the relationship between simplicity of design and lay-out, and individual differences in visual sensory processing to further unravel this notion.

Stimulus-evaluations. Two interesting findings resulted from the stimulus-evaluations. Firstly, there showed to be a difference in participants’ evaluations of images provided over the eHealth platforms. In specific, the selection of attractive and non-attractive properties of images in *MindDistrict* were found to be nearly evenly distributed. Contrarily, images in *TherapieLand* were predominantly judged as containing attractive properties. The difference in selections may be implied from the differences in participants' descriptions of their colouring. Namely, the colouring of images in *MindDistrict* was referred to as 'bright' and 'diverse' in relation to attractive properties, whereas the colouring of images in *TherapieLand* was stated to be 'natural' and 'calming'. The differential descriptions imply that images in *MindDistrict* cause greater levels of sensory stimulation than those in *TherapieLand*. As such, the difference in selections could relate to a general preference in users for lesser sensorially stimulating images in web-based interventions. Perhaps the preference for lesser levels of stimulation in images relates to the earlier-mentioned 'less is more' principle. That is, it may be that reducing visual clutter in web-based interventions nihilates distractions for both hypo- and hypersensitive users, so that all users may more readily achieve their goals.

Secondly, the present study found a predominant focus on humans and/or human faces in participants' evaluations of multiple visual stimuli. Specifically, the perceived attractiveness of visual stimuli was determined by participants through the facial expressions (i.e. indicative of happiness, or sadness and anger) and bodily gestures (i.e. open or closed gestures) of individuals. The findings imply that the active display of positive emotions in individuals, of which especially a smile, may thoroughly contribute to the perceived attractiveness of visual stimuli in web-based interventions. Many studies support the notion that the display of positive emotions enhances one's own emotions and evaluations through the occurrence of emotional contagion (e.g. Pham & Septianto, 2019; Setyawan, Anyndya, & Renada Fulongga, 2018). Nevertheless, such studies are mainly grounded in domains of marketing and management. Hence the present study encourages further research on the matter within the context of visual stimuli presented over web-based interventions.

Strengths and limitations

The present study knew multiple strengths resulting from its design and analyses of data. Firstly, the present study used both quantitative and qualitative methods of analysis. Specifically, this included correlational research combined with inductive content analyses. It is believed that the holistic approach upheld by the present study has provided the first step toward understanding the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions.

The second strength of the present study regarded the breadth of quantitative measures. Specifically, the present study utilised measures on visual sensory processing, expected user engagement, perceived system usability, visual sensory appeal, and final ratings of eHealth platforms to capture the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions in its entirety. As a result, the present study provides a range of focus-points for future studies to expand upon.

Thirdly, the self-developed measure on visual sensory appeal (VSAQ) may form a strength of the present study. The measure was developed by making use of key terms found in the AASP, and placing these in the specific context of experienced stimulation in the observance of visual stimuli. The relatedness in terminology between the VSAQ and AASP may have contributed to the finding of significant relationships between both measures that were in line with expectations. Scores on the VSAQ were indicated to be reliable, as its internal consistency showed to near excellent levels. As such, it is believed that the VSAQ may proof valuable for future research, albeit that the measure should first be validated.

The present study knew limitations as well. The first limitation regards the sample. Homogeneity within the sample was high, as it predominantly included young adults of Dutch and German origin. The use of a homogeneous sample may have caused data to be not normally distributed. In particular, this was confirmed for one of the AASP-quadrant scores with the use of normality tests. As such, it could be that the use of a homogeneous sample contributed to the insignificance of findings.

Secondly, the use of the AASP to measure visual sensory processing over web-based interventions may have been a limitation. Namely, five of the six modalities in the AASP do not relate to the visual domain (e.g. touch; smell), and hence are likely not involved in the experience of web-based interventions (Brown et al., 2001). Moreover, the visual modality-related questions of the AASP concern sensory processing of visual stimuli in real-life (e.g. daylight; colourful clothing) (Pearson Education, 2008). It is currently unclear whether differences in visual properties in real-life are directly comparable to those of visual stimuli in web-based interventions. Resultingly, findings with the AASP could be prone to context bias within this study domain. Such implications should be taken lightly, however, as the present study is the first to explore the relationship in question.

A further limitation regards difficulties with data collection for the AASP. Answers on the AASP for the sensory modality ‘smell’ were missing due to a technical error, meaning that AASP-scores were incomplete. Resultingly, it is unclear whether the present sample scored higher or lower on the quadrants compared to norm groups, or whether the present sample obtained quadrant scores that were indicative of hypo- or hypersensitivity. Notably, knowing the latter would be valuable, as it could partly explain the insignificant findings.

Lastly, the present study used web-based interventions developed by multiple external organisations, or eHealth platforms. The designs used by both eHealth platforms differed vastly, and properties could not be manipulated to identify their individual effects. Resultingly, findings are limited in specificity and generalisability. In addition, there were differences unrelated to the design, such as the informational content of black-and-white texts, headings and sub-headings. Consequently, it could be that responses on the measures regarding user-experiences (e.g. SUS; TWEETS) were biased, as participants may have included the non-design-related differences in their evaluations.

Implications for practice and further research

Regarding quantitative findings, the present study was unable to retrieve unified answers for the first two study questions, and could not establish significance for the latter two study questions. Nevertheless, it is believed that the present study was valuable in enhancing our understanding of the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions. Namely, the identification of limitations in the present study allows for the adaptation of study setups in future studies, so that the likelihood of obtaining clearer results may be increased. Specifically, the present study suggests the use of larger sample sizes to enhance the accuracy of results. In addition, it may be valuable to include participants of different age ranges and nationalities, as well as different (pre-established) sensory profiles. This would allow for a reduction of homogeneity within samples, which supports the generalisability of findings. Furthermore, the present study recommends the continued use of the AASP and VSAQ to provide further insights into their added value within the study domain.

Concerning qualitative findings, the present study was capable of identifying valued design-elements in web-based interventions, and differences in the perceived attraction of visual stimuli and their contributing properties. The findings are believed to form a valuable first impression of how individual differences in visual sensory processing may influence the perception of web-based interventions and associated visual stimuli. Nevertheless, the findings could be improved upon in future studies to account for the aforementioned lack of specificity and generalisability. In particular, the present study suggests the use of open interviews to collect participant-experiences of web-based interventions to allow for follow-up questions. Furthermore, the present study recommends the use of self-developed, standardised web-based interventions. Herein, researchers should include options to change single properties of the design (e.g. colour palette) or a visual stimulus (e.g. image-size) to evaluate their individual impact on user-experiences. Finally, it is believed that the use of implicit (e.g. eye-tracking; skin conductance) measures ought to be included in future studies. Namely, implicit measures would allow for more thorough analyses of the experiences of over- and understimulation in participants during their interactions with web-based interventions. Moreover, the use of implicit measures would support better linkage of qualitative and quantitative findings, such as with the AASP and VSAQ.

Conclusion

The present study is believed to be the first to explore the relationship between individual differences in visual sensory processing and user-experiences of web-based interventions. The quantitative findings showed to be limited and contradictory, and thereby challenged the existence of the relationship in question. Nevertheless, the qualitative findings provided implications that encourages future research within the domain. Namely, results indicated participants to have a general preference for lesser sensorially stimulating visual stimuli in web-based interventions. As such the present study raised the question whether a ‘less is more’ principle may be at play for all users of web-based interventions, as reducing visual clutter may support the speed and ease of goal obtainment. Moreover, the present study brought into question the contribution of positive emotions displayed by individuals, of which especially a smile, in enhancing the perceived attractiveness of visual stimuli in web-based interventions. Future research is needed to further unravel the relationship, in which the use of self-developed web-based interventions, open interviews, implicit measures, and the use of the VSAQ alongside the AASP are recommended.

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Appendix

Appendix 1: Screenshots of the web-based interventions in MindDistrict

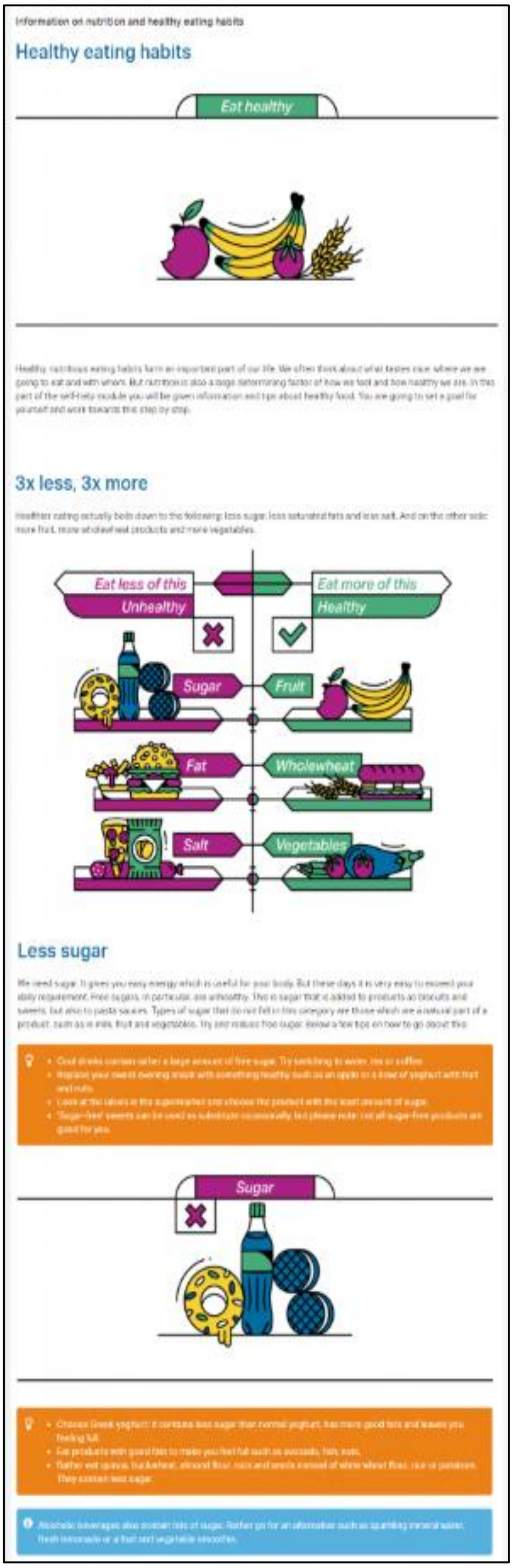


Figure 5. Screenshot of the web-based intervention 'Nutrition' in MindDistrict.

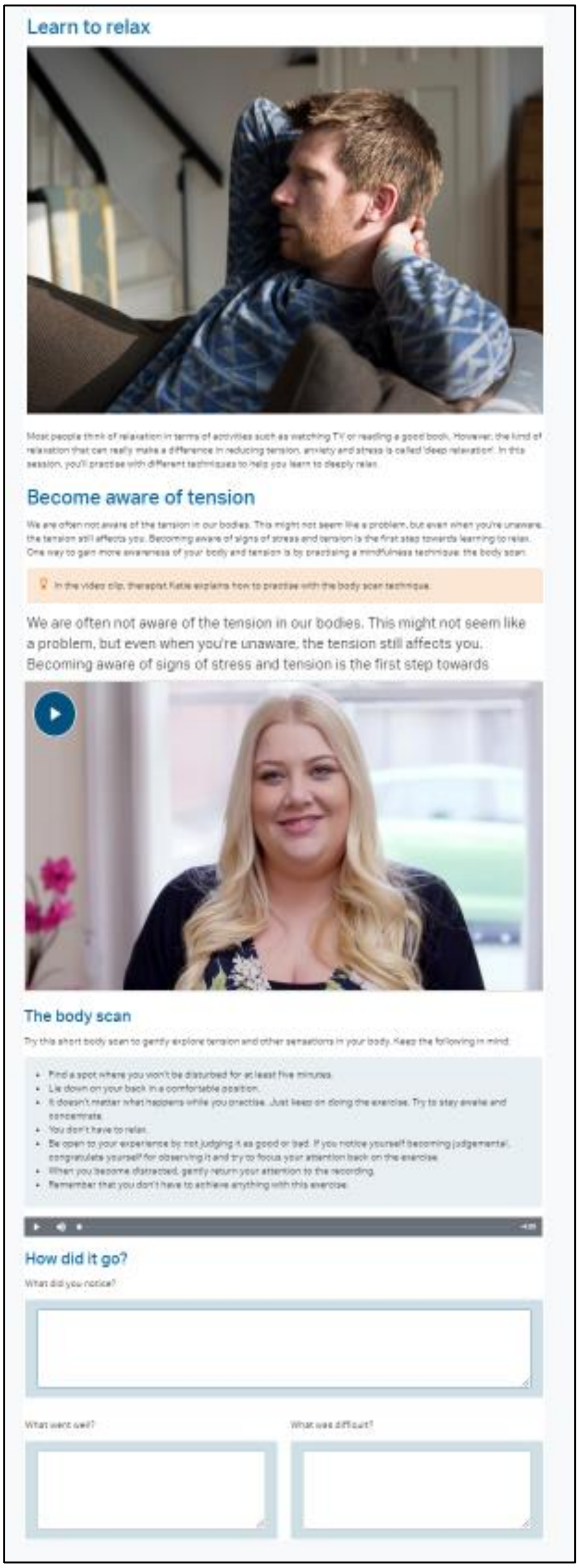


Figure 6. Screenshot of the web-based intervention 'Relaxation' in MindDistrict.

Appendix 2: Screenshots of the web-based interventions in TherapieLand

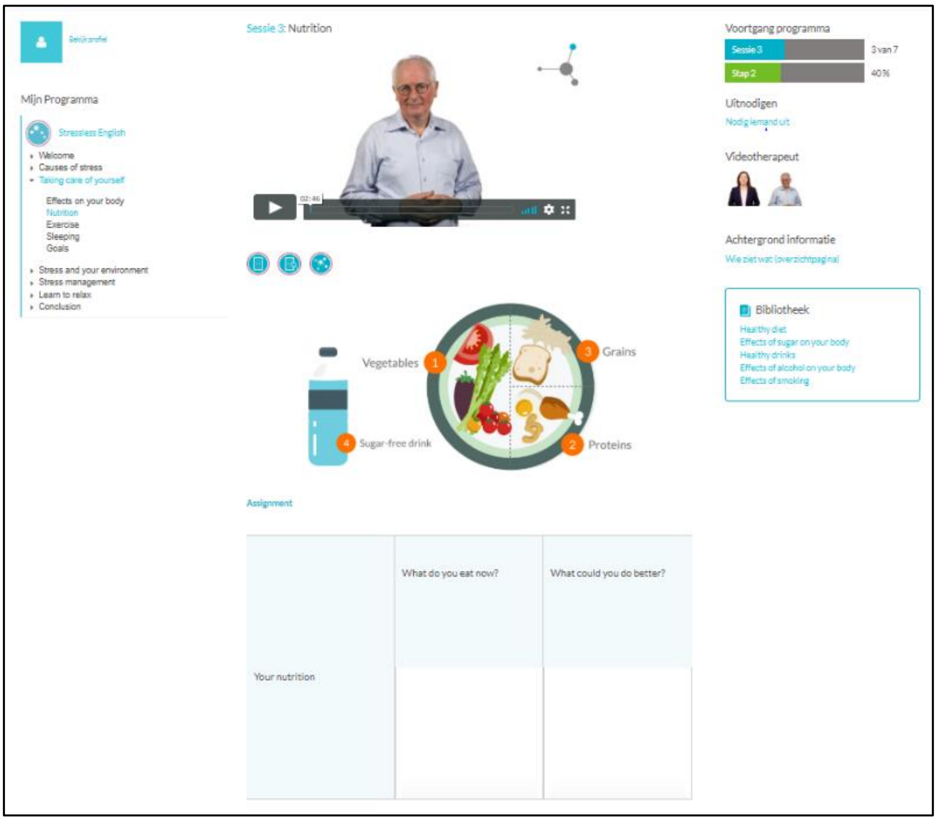


Figure 7. Screenshot of the web-based intervention 'Nutrition' in TherapieLand.

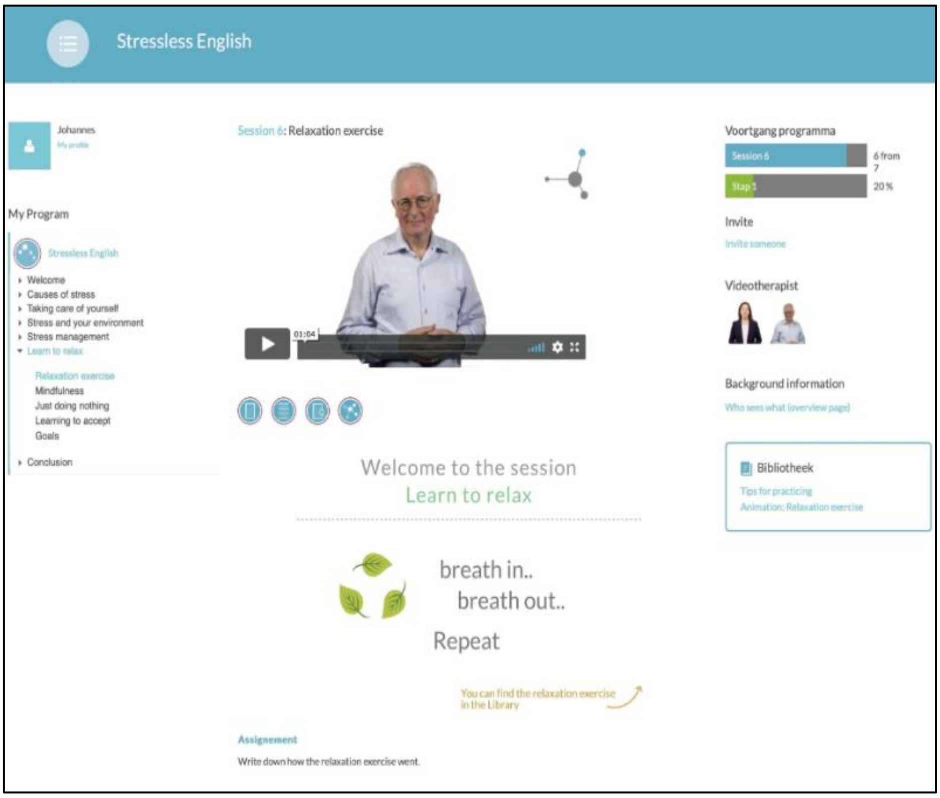


Figure 8. Screenshot of the web-based intervention ‘Relaxation’ in TherapieLand.

Appendix 3: Scenarios

3.1 Scenario written for the topic 'Nutrition'

"You've read on social media that studies found that healthy eating increases your happiness, mood, and overall quality of life. This finding triggered your curiosity. You wonder if you would be able to make some changes to meals yourself, in order to make them more healthy and nutritious. As such, you have decided to look into websites that provide you with guidelines on how to develop a healthier eating pattern. This search has brought you to two eHealth websites; *MindDistrict* and *TherapieLand*, which you believe may help you further."

3.2 Scenario written for the topic 'Relaxation'

"You've read on social media that studies found that relaxation exercises reduce your stress and increase your happiness, mood, and overall quality of life. This finding triggered your curiosity. You wonder if you would be able to perform relaxation exercises in your daily life, in order to reduce stress and feel calm. As such, you have decided to look into websites that provide you with guidelines on how to reduce stress and increase relaxation This search has brought you to two eHealth websites; *MindDistrict* and *TherapieLand*, which you believe may help you further."

Appendix 4: Coding schemes

Table 6

Coding scheme for the First Impressions and Stimulus-evaluations of the Web-based Intervention 'Nutrition' in MindDistrict

First Impressions			
Valence (44 responses)	Design-element	Practical application	Example quote
Positive (41%)	Colouring (18%)	Attention-grabbing	it's very bright and colourful
		Contrast	Even though I do not like the purple colour it creates a lot of contrast to the yellow
	Simplicity (13%)	Little distractive elements	The app looks plain without too many distractions
		Little text	Not too much text, very clear and appealing
	Visuals (10%)	Visually pleasing	Quite nice visuals
		Visual support	The information is presented with a lot of visual support (images, boxes, colours)
Negative (39%)	Simplicity (16%)	Too much text	It's rather tedious to read the text. I would prefer less text or more highlighted text [..]
		Mispositioning information	[..] the things that are more important , are on the very bottom and in small letters
	Colouring (10%)	Colour palette	The chosen colours are very ugly and seem unsympathetic to me
		Too many colours	Many different colours and a lot of text
	Visuals (7%)	Large image sizes	Too big and too colourful drawings that distract me from the text [..]
	Readability (6%)	Small font	The font is too small, it does not invite me to read the whole paragraphs.
Irrelevant (20%)			
Stimulus-evaluations			
Stimulus-type (218 selections)	Attractiveness	Property	Example quote
[a] Title (2%)	Attractive (1%)	Attention-grabbing	Green colour, the words eat and healthy, exactly what I am looking for
	Non-attractive (1%)	Repetitive	This subheading is repetitive yet in bold text and confusing me [..]
[b; f] First/third image (26%)	Attractive (11%)	Drawing-style	Also like the minimalistic comic design of this one [..]
		Colour palette	Yellow didn't appear in any of the other pictures, makes it stand out and look tasty
	Non-attractive (17%)	Drawing-style	Soft drink might be in a different colour and a bit more soft shapes
		Colour palette	Terrible colours, nothing looks healthy (even the healthy food)
[c] '3x less, 3x more' (2%)	Attractive (2%)	Attention-grabbing	It is catchy [..], the mix between numbers and letters also makes it visually interesting
[d] Second image (43%)	Attractive (28%)	Colour palette	The table is colourful and also easy to keep in mind due to the simple graphics
		Drawing-style	It looks nice and gives me the information I need more quickly
		Adequate size	Large image: this draws my attention
		Important information	[..] The colours are right indication of what is healthy and what not
		Little text	[..] images usually are what I look at first, after that I go on to read through the text
	Non-attractive (17%)	Colour palette	The colouring is highly repetitive (especially on both sides of the spectrum [..])
		Distracting size/position	Distracts because too big and in the centre of attention
[e; g] Orange tabs (14%)	Attractive (8%)	Colour	[..] The colour catches my attention
		Important information	Light bulb: normally meaning top tip or key information
	Non-attractive (6%)	Colour	The orange colour is a bit too intense for my liking
		Too much small text	The text is too small and it could be a bit more concise
[h] Blue tab (5%)	Attractive (3%)	Colour	The blue colour is not too bright but it catches my attention [..]
		Important information	'I' in the bubble: extra information
	Non-attractive (2%)	Colour	The colour of text box is not appropriate for reading
		Too much small text	Looks like a long text in a small font.
Unidentifiable (8%)	Irrelevant (3%)/Unidentifiable (3%)		

Note. Findings for the first and third image were grouped due to their identicality in codes.

Table 7

Coding scheme for the First Impressions and Stimulus-evaluations of the Web-based Intervention 'Nutrition' in TherapieLand

First Impressions			
Valence (45 responses)	Design-element	Practical application	Example quote
Positive (61%)	Simplicity (49%)	Clean design	Modern, pleasing, soft, clear, clean, well-balanced
		Little text	Little amount of text
		Clear structure	Simple design with the most important information in the centre [..]
		Little distractive elements	It looks plain and does not contain too many distractions
	Colouring (5%)	Colour palette	Clean design, less text, less colours
	Multimedia (5%)	Inclusion of video/exercise	Like that there is a video included and graphics one can work on
	Visuals (2%)	Inclusion of people	It seems like they try to interact more on a personal level, especially because in the video and to the right there are actual humans presented
Negative (37%)	Simplicity (22%)	Too little text	Maybe some text would make it easier to look for information rather than a video
		Unclear structure	It's messy and a lot going on, I don't know where to start or what the structure is
	Visuals (10%)	Uninteresting	The website looks rather dated and uninteresting
	Scaling (5%)	Small size	Everything is quite small.
Irrelevant (2%)			
Stimulus-evaluations			
Stimulus-type (208 selections)	Attractiveness	Property	Example quote
[a] Programme (13%)	Attractive (3%)	Clear structure	Separated in different topics/areas, makes it less overwhelming [..]
	Non-attractive (7%)	Small size	It's hard to read because it's so small
		Too much text	A lot of information, densely packed in a small part of the screen
[b] Video (18%)	Attractive (7%)	Presenter	Looks like an expert, I'd like to hear his explanations
		Attention-grabbing	The video is eye-catching and I expect to receive some information through it
		Navigation	[..] It allows me to easily dive into the website by simply starting the video
	Non-attractive (1%)	Presenter	It's an older man, and therefore I have the feeling that the website is for older people.
[c] Image (25%)	Attractive (23%)	Clear structure	The graphic is simple and easy to understand and remember
		Colour palette	More natural colours; looks like something to interact with
		Drawing-style	A nice visualization of a healthy diet
		Visual support	[..] It is a clear representation of what is good without forcing the user to watch a video
	Non-attractive (1%)	Confusing	I do not yet know what the numbers are referring to, therefore they distract me [..]
[d] Exercise (16%)	Attractive (5%)	Clear structure	Space to fill out that is not overloaded
	Non-attractive (9%)	Colour palette	This takes up a lot of space, however it is just ugly, no colour [..]
		Unclear structure	It is kind of messy, you don't know where to start first
[e] Additional info-box (16%)	Attractive (8%)	Attention-grabbing faces	Well there are humans and I just felt wired to look there first
		Attention-grabbing colours	Eye-catching because of colours
		Clear structure	The bar chart [..] gives me some direction
	Non-attractive (4%)	Distracting	Too many menus on page, might be better to pop-up
		Boring	The table might have a better design, not so simplistic
		Colour palette	Don't like the green next to the blue
		Small size	This also just seemed unnecessary and difficult to read
Unidentifiable (12%)	Irrelevant (25%)/Unidentifiable (7%)		

Table 8

Coding scheme for the First Impressions and Stimulus-evaluations of the Web-based Intervention 'Relaxation' in MindDistrict

First Impressions			
Valence (45 responses)	Design-element	Practical application	Example quote
Positive (43%)	Simplicity (32%)	Clear structure	Well-structured and easy to read and watch
		Clean design	Overall impression, everything is clean and well structured
	Visuals (11%)	Visually pleasing	Nice pictures, seems interesting
		Calming	Soothing because of the man that is relaxing
Negative (53%)	Simplicity (27%)	Unclear structure	[..] It doesn't look structured
		Too much text	A lot of text in different areas [..]
	Visuals (17%)	Negative affect	He doesn't look relaxed, he seems agitated and that makes me stressed
		Distracting size	[..] The photo and the video are really dominant (visually)
	Readability (9%)	Text size/colouring	[..] The text is a little hard to read (due to its size and colouring)
Irrelevant (4%)			
Stimulus-evaluations			
Stimulus-type (162 selections)	Attractiveness	Property	Example quote
[a] Image (16%)	Attractive (6%)	Person in image	Nice to see how relaxed he looks like
		Fitting to topic	It shows me clearly what I can learn from it
	Non-attractive (10%)	Large size	The picture is too big compared to the text
		Person in image	Man does not look relaxed but in a state of discomfort, it's unpleasant
[b] 'Become aware of tension' (4%)	Attractive (4%)	Attention-grabbing	This headline is catchy
[c] Black-on-white text (5%)	Non-attractive (5%)	Too much text	Need to read a lot of text
		Crowded between text	[..] It does not have the space that it deserves to convert the message
[d] Orange tab (10%)	Non-attractive (5%)	Small size	Small font in this area
		Too much text	It is [..] too crowded to be read quickly
[e] Video (23%)	Attractive (16%)	Attention-grabbing	[..] The video of the girl was eye-catching, it was positive
		Presenter	The woman looks friendly and is directed towards me, as if she would speak to me
	Non-attractive (7%)	Presenter	The woman doesn't look friendly
[f] Blue tab (16%)	Attractive (8%)	Clear structure	Step-by-step instructions, easy to follow
	Non-attractive (6%)	Too much text	The box at the bottom is way too full with text [..]
		Small size	[..] Text that is written in really small letters
[g] Sound recording (2%)	Non-attractive (2%)	Missing headline	I don't recognize what the audio file is about due to the lack of information
[h] Exercise (16%)	Attractive (12%)	Attention-grabbing	Eye-catching: it takes up some space and I can write in it, so I am addressed in a way
		Clear structure	Dividing things in points makes it clearer to understand
	Non-attractive (4%)	Large/many textboxes	The large textbox makes me feel like I have to write a lot
		Unclear use	An empty text box, I don't want to enter text. Who is going to look at it?
Unidentifiable (8%)	Irrelevant (10%)/Unidentifiable (5%)		

Table 9

Coding scheme for the First Impressions and Stimulus-evaluations of the Web-based Intervention 'Relaxation' in TherapieLand

First Impressions			
Valence (45 responses)	Design-element	Practical application	Example quote
Positive (74%)	Simplicity (62%)	Clear structure	Looks organised and well put together
		Clean design	Clean and simple design
		Calming	The minimal design has a really comforting effect on me
	Colouring (6%)	Contrast	Good contrast between colour, clean and structured
	Visuals (4%)	Presenter	I am intrigued by the man [..]
	Multimedia (2%)	Inclusion of exercise	The exercise of breathing in and out stands out, that is what I want [..]
Negative (22%)	Simplicity (11%)	Unclear structure	There is information on the side that does not seem to matter to me. The space is not really used that well
	Visuals (11%)	Understimulating	Seems even more professional but also a little bit boring now
Irrelevant (4%)			
Stimulus-evaluations			
Stimulus-type (157 selections)	Attractiveness	Property	Example quote
[a] Logo (1%)	Non-attractive (1%)	Understimulating	It is the logo, it has a certain contrast to the white, but it is ugly and it is not present [..]
[b] Programme (9%)	Attractive (2%)	Clear structure	Well-structured in different topics to give a better overview
	Non-attractive (7%)	Unclear structure	This looks a bit messy
		Distracting	The blue box takes a lot of attention, but does not deserve the attention
		Too small text	Small fonts, looks hard to read
[c] Video (21%)	Attractive (15%)	Attention-grabbing	I would be interested in watching the video
		Navigation	Video in front of a clean background guides through the site
		Presenter	Looks friendly and directed towards me, I fell addressed
	Non-attractive (6%)	Background colour	Not colourful enough, looks too clinical
		Presenter	Older man: older man in combination with a simple website does not fit my age
[d] Image (29%)	Attractive (24%)	Attention-grabbing visuals	Leaves and circular motion seems eye-catching
		Attention-grabbing text	The graphic is nice and easy to remember with the text next to it
		Calming	The three leaves caught my attention the most and have a relaxing effect on me
		Colour palette	Nice to add the green colour to complement the blue layout
		Drawing-style	Exercise to relax, nice displayed
		Engagement	Leaves remind you of inhaling
		Fitting to topic	I think that the exercise has something to do with the text. And that is good [..]
	Non-attractive (5%)	Positioning	Look misplaced in the middle of the page, better at the top as a heading
[e] Exercise (12%)	Attractive (8%)	Clear structure	Providing only one text box for taking notes ensures a clean and non-distracting view
	Non-attractive (4%)	Contrast	The exercise instructions could be more highlighted, as they blind in strongly with the rest of the page
[f] Additional info-box (8%)	Non-attractive (8%)	Distracting	A lot of information that does not seem to matter to the task at hand
[g] Hyperlinks (2%)	Non-attractive (2%)	Too little text	I want to have everything directly on the page without having to click on tons of links
Unidentifiable (8%)	Irrelevant (12%)/Unidentifiable (6%)		

Appendix 5: Heatmaps of 'Nutrition' in MindDistrict

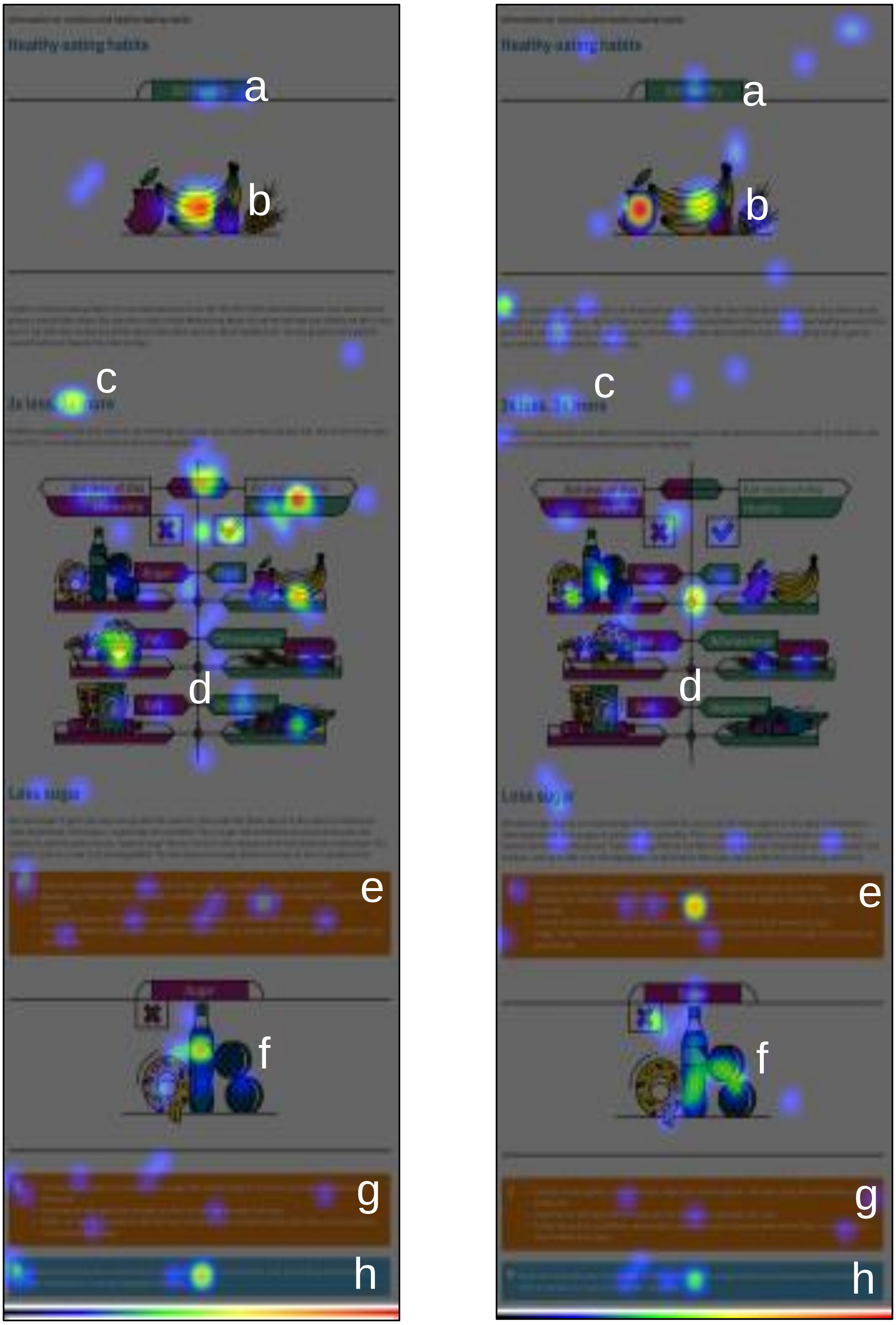
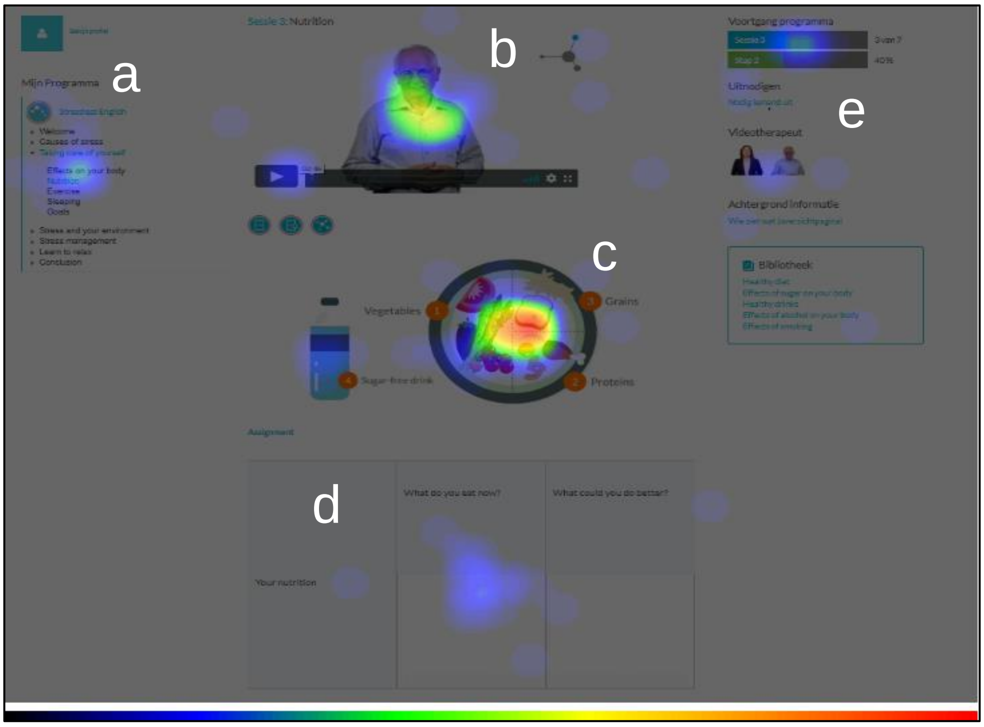


Figure 9. Heatmaps of the attractive (left) and non-attractive (right) properties of visual stimuli in the web-based intervention 'Nutrition' in MindDistrict.

Appendix 6: Heatmaps of 'Nutrition' in TherapieLand



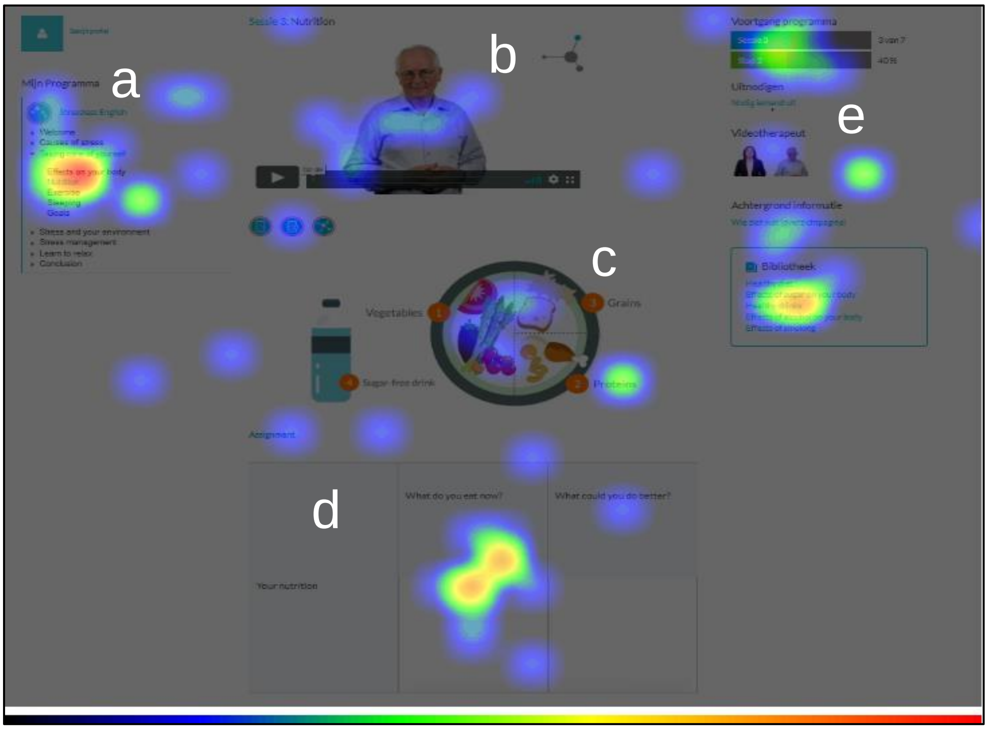


Figure 10. Heatmaps of the attractive (above) and non-attractive (below) properties of visual stimuli in the web-based intervention 'Nutrition' in TherapieLand.

Appendix 7: Heatmaps of 'Relaxation' in MindDistrict

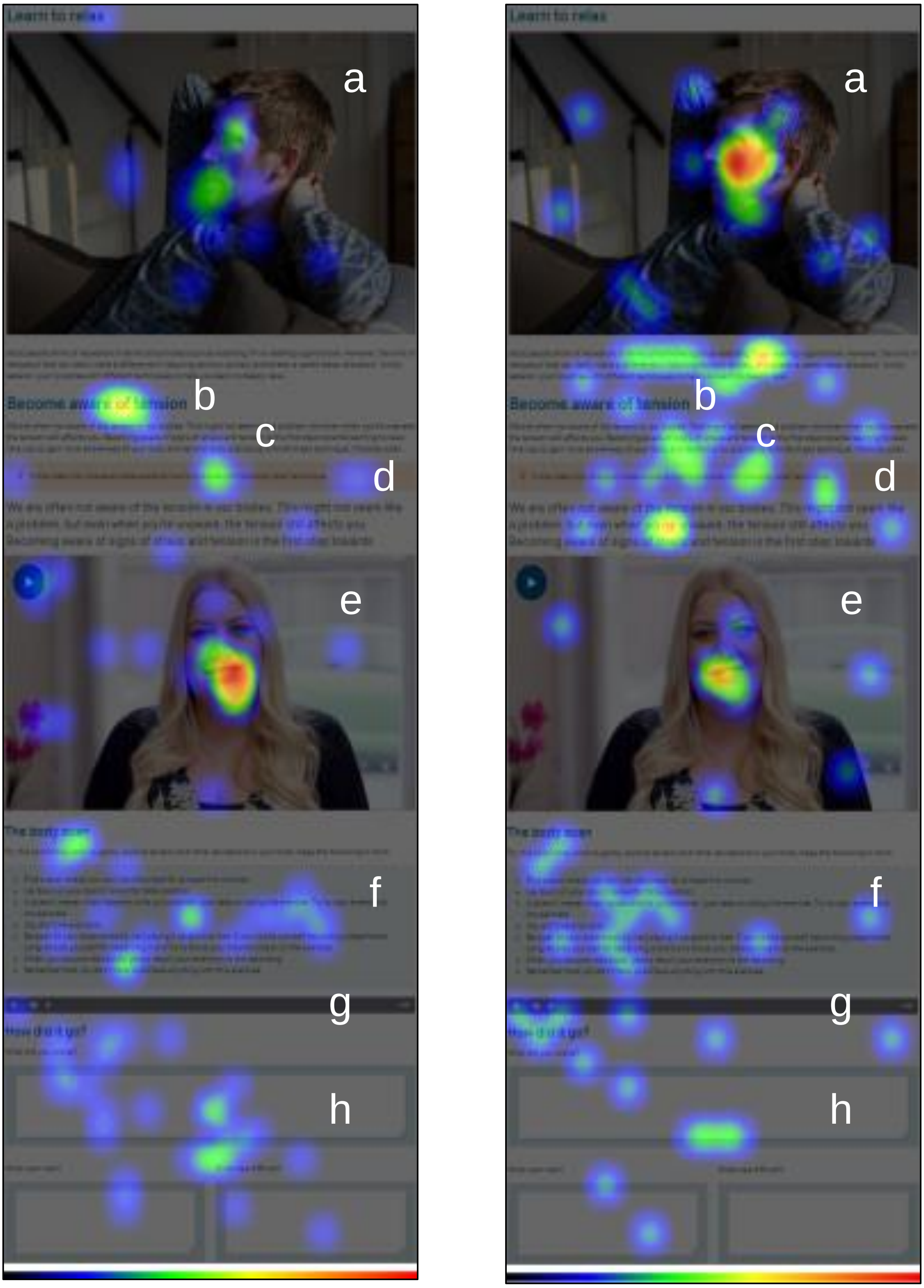


Figure 11. Heatmaps of the attractive (left) and non-attractive (right) properties of visual stimuli in the web-based intervention 'Relaxation' in MindDistrict.

Appendix 8: Heatmaps of 'Relaxation' in TherapieLand

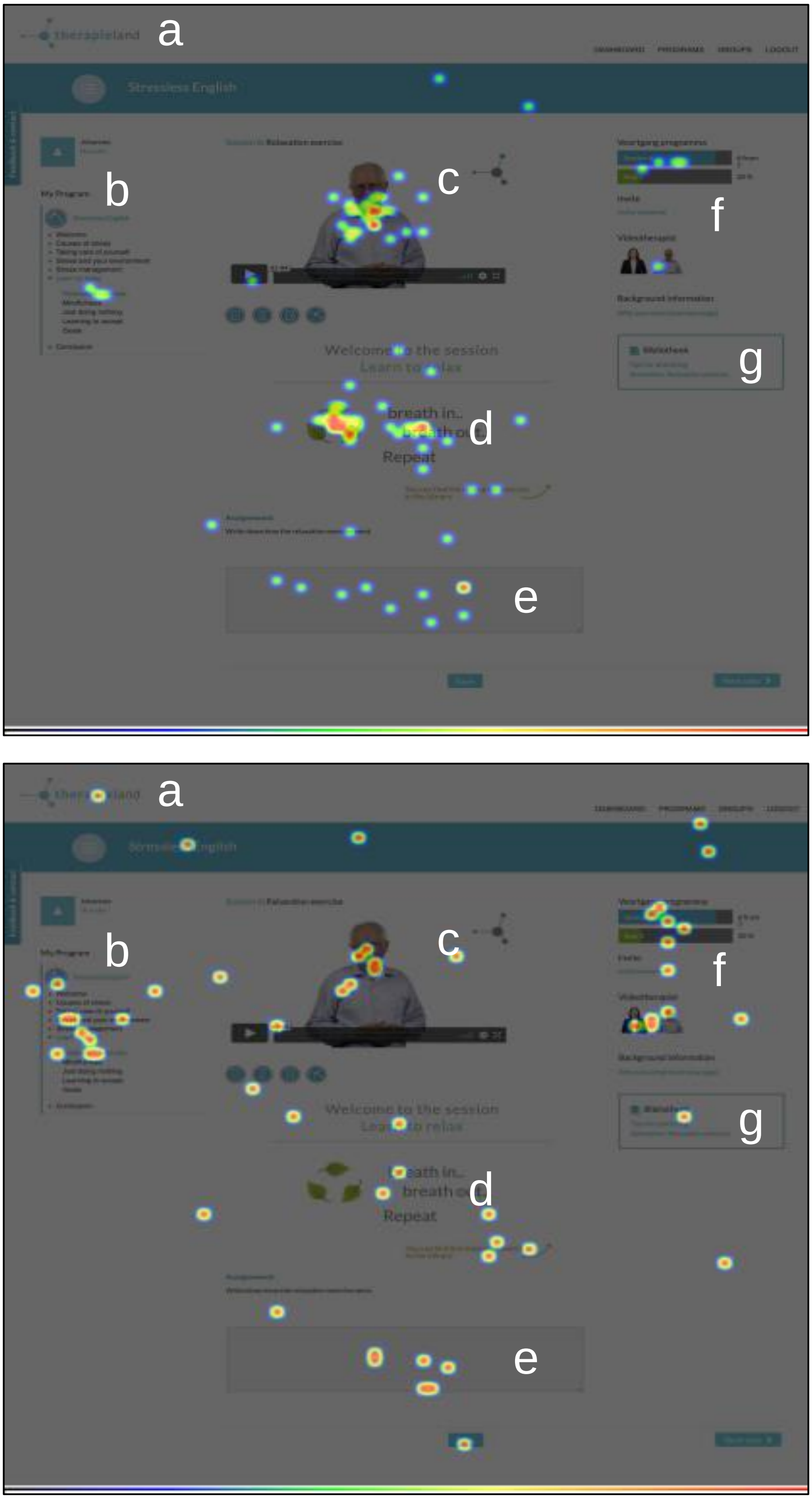


Figure 12. Heatmaps of the attractive (above) and non-attractive (below) properties of visual stimuli in the web-based intervention 'Relaxation' in TherapieLand.