A Replication Study on Visualising the Implicit Self-Image Using Reverse Correlation

Milou Verspui[1]

Deniz Yılmaz[1]

Author Note

[1] Faculty of Behavioral and Social Sciences, Utrecht University, Utrecht.

This research has been supervised by Dr. Loek Brinkman, Department of Psychology, Utrecht University, Utrecht.

Contact: d.yilmaz@students.uu.nl, l.m.verspui@students.uu.nl

Abstract

Representation of the self can give insight into an individual's mental well being. The current study aims at validating reverse correlation, as a means to produce a visual representation of self-image. Possible diagnostic and therapeutic implications of a visual implicit self-image are also investigated. Thirty one university students were recruited for the reverse correlation task of self-image creation. They were later interviewed on their self-images. Additionally, diagnostic applicability was investigated by re-analysing an existing dataset on CES-D scores and independently assessed depression of reverse correlation output. The results show that participants were generally successful in recognising their self-images. The images motivated the participants to think self-reflectively in the context of an interview. A stronger correlation of CES-D scores and assessed depression was found for a cutoff of the dataset, for CES-D scores of 16 and above. This study can be considered a step towards validating reverse correlation as a means to produce self-image. Furthermore, diagnostic applicability of the method should be further investigated on clinical samples. Lastly, the method could have potential for therapeutic settings, as it seems to be a useful tool for facilitating reflective thinking about the self.

Keywords: self-image, reverse correlation, implicit, mental representation, depression

A Replication Study on Visualising the Implicit Self-Image Using Reverse Correlation

Self-images internalized by people (e.g. I am invaluable, depressive, incapable) can bear significant clues regarding their psychological characteristics. Furthermore, distorted self-image was found in patients with numerous psychiatric disorders including anorexia nervosa, depression, social anxiety disorder, and alcoholism (Mantilla, Bergsten, & Birgegård, 2014; Paredes, Ludwig, Hassenfeld, & Cornelison, 1969; Anderson, Goldin, Kurita, & Gross, 2008; Erkolahti, Ilonen, Saarijärvi, & Terho, 2003) and psychotic disorders (Bentall & Kaney, 1996).

Thus, self-image bears diagnostic importance in clinical settings. For example, specific patterns of self-representation are observed in patients with social anxiety disorder (Anderson, Goldin, Kurita, & Gross, 2008), depression (Segal, 1988; Shestyuk & Deldin, 2010), and psychopathy (Paulhus & Williams, 2002). In addition, evidence-based therapeutic approaches, such as cognitive behavioral therapy (CBT) and competitive memory training (COMET), are shown to exert their effects at least in part by modifying self-representations and improving positive self-image (Goldin, Jazaieri, Ziv, Kraemer, Heimberg & Gross, 2013; Harpaz-Rotem & Blatt, 2009; Korrelboom, Maarsingh & Huijbrechts, 2012). However, to date, measuring self-representation has relied heavily on patients' self-reports, which might bring certain limitations due to their explicit nature. In order words, patients might be unaware of the implicit biases they hold or unwilling to acknowledge them due to social desirability.

It is then intriguing to imagine, that one could visualise a reflection of one's implicit mental (self-) image, and potentially use this in clinical settings. For example, as diagnostic and therapeutic tools. That is, visualised self-images could be used to assess whether a person shows patterns of distorted self-representation that are diagnostically relevant for clinical disorders.

Additionally, within a therapeutic setting, a visualisation of self-image might give patients more insight into their self-image, as having actual visual feedback could be more confronting to the patient. The implicit image would be an especially useful addition, as it bears the potential of representing aspects of self-image that might not be consciously acknowledged by the patient. In that way, the patient can confront a more complete self-representation, that is captured beyond the limitations of the conventional methods. For instance, a sad looking self-image can be produced by a patient, who is not fully aware or reluctant to acknowledge the sadness they are experiencing. Visualising this image might help the patient to acknowledge ongoing problems and encourage them to overcome their situation.

Current developments may in fact enable us to investigate implicit mental images. A relatively novel technique called reverse correlation utilizes repetitive trials in a forced choice paradigm. The utilized stimuli consist of randomly generated noise masks, which are superimposed onto averaged face stimuli (Dotsch & Todorov, 2012). This creates images with different facial features, of which one should be picked out of two in each trial. The participants select one image that reflects best their mental image regarding a specific representation. A meaningful image can be generated by averaging the noise patterns chosen by the participant, and superimposing this composite onto the same average face. The outcome is referred to as a Classification Image (CI), and would represent an approximation of the mental image of the participant of the target trait.

Originally, reverse correlation was used for visualising facial features that might be predictive of certain types of social judgement. For instance, using reverse correlation, a trustworthy face was found to be associated with small, smooth-looking, and smiling expression

(Dotch & Todorov, 2012). Reverse correlation was also utilised to reveal top-down biases that may be present in certain social judgement situations (Brinkman, Todorov, & Dotsch, 2017). Features that have been investigated by reverse correlation include; trustworthiness and dominance (Dotsch & Todorov, 2012; van Driel, Leijenaar & Kusters, 2017) or other social elements in face perception such as trait judgments (Dotsch & Todorov, 2012), prejudice (Dotsch, Wigboldus, Langner & Van Knippenberg, 2008) and in-group projection (Imhoff, Dotsch, Bianchi, Banse & Wigboldus, 2011).

For example, one study using reverse correlation revealed that mental representation of an average Moroccan face held by an implicitly negative-biased person, was rated to be more criminal by independent participants (Dotsch et al., 2008). This shows that, certain characteristics of reverse correlation technique helps shedding light onto subtleties of perception, like implicit categorisation of facial features, which are difficult to capture by commonly used methodologies in the literature. Therefore, CI's generated by reverse correlation studies can be considered as an approximation of unrestrained implicit mental representation (Dotsch & Todorov, 2012). If this technique indeed provides us a means to investigate implicit social perception of faces, it could also be used to produce an image of the implicit self. The focus of the current study is the potential of this method for creating self-images and capturing a variety of facial features. Considering the implicit nature of reverse correlation and the strengths that stem from this nature, investigating unconstrained self-images can be interesting in its own right and also for the clinical relevance of self-image. The fact that reverse correlation is a data-driven methodology, is especially useful in the case of self-image, since it is the participant who determines (perhaps unconsciously) what criteria to use for evaluating their self-image.

To date, a limited number of studies used reverse correlation method for creating self images. Dotsch and Imhoff (2013) made use of self-images in their study investigating visual ingroup projection, as they tried to account for effects of self-projection. Shorten (2017) utilized this technique to inquire the relationship between self-esteem and positivity of visual self-image representations. Relevant to our interest, a pilot study conducted by Brinkman & Kennis (2017), utilised reverse correlation to achieve a visualisation of mental self-images. The study aimed at validating reverse correlation as a means to produce self-image. In addition to a true self-image (i.e. an approximation of how the participants mentally represent themselves), each participant also created an ideal self-image (i.e. how the participants would like to be). The study further focused on the self-images' possible use as diagnostic or therapeutic tools.

They investigated several hypotheses. First, a self-recognition task assessed the hypothesis that the generated ideal and true self-image would be recognised by the participants. Subsequently, possible diagnostic implications were explored by investigating whether there would be a positive relationship between the discrepancy of ideal and true self-image in positivity (rated by independent participants), and the scores on Center for Epidemiologic Studies Depression (CES-D) scale. This 20 question self-report scale is utilised to measure symptoms of depression in the general population. The scale measures symptoms that have been confirmed to be associated with depression by previous, longer scales (Radloff, 1977). Lastly, the therapeutic applicability of the method was assessed by confronting the participants with their generated CI's. Here, they hypothesised higher discrepancy between true and ideal CI's would be positively correlated with motivation for self-improvement. Sixty percent of the participants could recognise their generated true self-images at first attempt. The statistics for

ideal self-image recognition were not reported by the authors. Moreover, a significant predictive value of CES-D scores was found for the independently judged discrepancy scores ($r^2 = .26$). Finally, a trend was observed between discrepancy scores and motivation for improvement, although the results did not reach significance.

The results of the first experiment on true CI's were in line with the expectations of the authors as most of the participants recognized their CI's on the first trial. Since the effect size value for the recognition study is lacking in the study-to-be-replicated, a calculation was done using the programme G*Power 3.1.9.2. This resulted in an effect size of w = 1.18. Coupled with the significance value ($p < .01$), the calculated effect size adds to the strength of evidence of the first experiment (see the methods section for further details). Due to the relatively small sample size of 25 participants, considering the prerequisite of running a chi-square test with high enough expected counts, it remains a possibility that the findings reflect a type-1 error. Thus, overestimating the expected effect size value. Furthermore, even though the second experiment might be considered a within study replication by demonstrating the relationship between CI ratings and depression, no other study has replicated these results.

This study aims to scrutinize the validity of reverse correlation on visualising self-image by replicating the first experiment of the Brinkman & Kennis (2017), which entails the generation of true and ideal CI's, and recognition of these CI's by the participants. Validating this method for self-image creation in turn constitutes the first step of extending the utility of CI outside of laboratories into clinical settings as a diagnostic and therapeutic tool. Taking into account the required investment of time and funding to establish a complete diagnostic and/or

therapeutic tool, replication of these findings and increasing confidence in the potential utility of reverse correlation is substantial.

The main research question of this study is whether this method is a valid and reliable tool to visualise self-image. For this, confirmatory analyses were conducted to investigate the hypothesis that classification images will be recognised by the participants. At least fifty percent of the participants were expected to recognise their true and ideal CI's on first trial, thereby fortifying the conclusions of Brinkman & Kennis (2017). Moreover, we hypothesised, that participants would recognise their CI's more frequently on the first three trials (recognition in either one, two or three tries) than the last three trials (recognition in either four, five or six tries). The diagnostic (predictive validity of the assessed depression on depressive symptoms) and possibly the therapeutic (confronting participants with their CI's) applicability of the visualised self-images with reverse correlation were also explored.

The strength of evidence regarding the diagnostic applicability of reverse correlation, i.e. correlation of CES-D and independent positivity ratings, is not very convincing. Although this study revealed a high effect size (r^2 = .26), a between study-replication of this high effect size could not be achieved. A similar analysis was conducted in a different study with over a hundred participants (Brinkman & Kennis, 2018). This study did not find the same result and yielded a very low effect size (r^2 = .03), even though the result was significant. Differential conceptualisation of independent ratings likely contributed to this contradiction. The original study used independent ratings of positivity, whereas the replication study with a low effect size used depression ratings. These two concepts might have been interpreted differently by the independent group, as an angry looking face might be rated negative but not depressive.

In the study of Brinkman and Kennis (2017), all participants were rated on positivity difference between the true and ideal self-images by 17 independent raters, and these ratings were subsequently correlated with the participants' CES-D scores. This within-subject design yielded that 25.7% of the variance of the CES-D scores was accounted for by the positivity ratings ($p < .01$). Looking at the graph produced by this study, a random pattern for participants with low CES-D scores is seen (see Figure 3). However, focusing on the participants with high CES-D scores, there seems to be a trend towards a positive correlation. The analysis did not make this distinction, however, this oversimplification of the data may have resulted in a type-2 error and thereby obscured the actual magnitude of the effect in the population.

With an effect size of $r = .18$ and power of .80, we would need 232 participants to replicate this study ($\alpha = .05$, two-tailed), as calculated on G*Power. If the effect size in the population were indeed that low ($r = .18$), the required number of participants would be too many. Considering the logistical difficulties of finding over 200 participants, we decided to re-analyse the additional data instead of collecting data all over again. The possibility remained that focusing on certain parts of the sample could yield more meaningful effect sizes on this data. Different percentiles were cut-off from the original data to explore whether the correlation and effect sizes were more meaningful above certain CES-D scores. These cut-off points included the clinically relevant red flag score of 16 (Radloff, 1977); and 25th, 33th, 50th, 66th, and 75th percentiles. A CES-D score of 16 or higher indicates that the participant might have symptoms of clinical depression, suggested by the literature (Radloff, 1977). Accordingly, higher CES-D scores might prove as a more robust predictor of rated depression.

Last, a second exploratory analysis was conducted investigating the therapeutic utility of reverse correlation. The second exploratory analysis cannot be considered an absolute replication. Despite being inspired by the questions posed in the original study, we prepared a different set of questions for the interviews that focused on details that were not covered by the original study. Our participants were requested to compare their real selves with the true and ideal CI's they have created. Moreover, they compared the true and ideal CI's. Our study differentiates from the original study, as we investigated the variable of used strategy (physical focus, psychological focus or both) to create the CI', as well as mood. One can argue, that the strategy bears importance in capturing the self-image as a whole, and not reflecting a mere physical proxy of the participants abstained from emotions. Specific predictions were not made for these analyses, and a rather exploratory approach was taken to analyse the interview output and discover patterns within them.

Methods

Participants

Thirty two participants (M_{age} = 20.65, SD_{age} = 2.46) were recruited from universities in the Netherlands. The sample size was determined with the aid of programme G*Power 3.1.9.2. The calculated effect size of the original recognition study was w = 1.18 (χ^2 test, df = 5, α = .05, N = 25). A power of .99 was computed, which is extremely high and therefore could be an overestimation of the effect-size in the population, as it is based on a relatively small sample size. Being more precautious, the expected effect size was lowered on G*Power. In addition, power was increased in order to decrease our chance of missing any effect present in the population (w = .90, Power = .95, α = .05, df = 5). The analysis yielded a required sample size

of 25. Accounting for the sample size assumption of Chi-square test (Yates, Moore, & McCabe, 1999, in Weaver, 2017) and the expected attrition rate, the present study aimed at a replication with a a sample size between 30-40 participants and ultimately recruited thirty two participants. However, one participant was excluded because they misunderstood the instructions and did not complete the CI creation task, leaving thirty one participants for the analyses.

Twenty one participants identified themselves as women and ten identified as men. All the participants were undergraduate or graduate students from a variety of departments. Psychology students from Utrecht University who attended the experiment were able to obtain course credits as an incentive. Three of the participants utilized this option. Exclusion criteria were age (being below the age of 18 or above 65), task completion time (completion time of three standard deviations below the mean) and left/right bias (clicking more than 100 times consecutively on the left or right picture). No participants were excluded from the confirmatory analysis, due to these criteria.

Stimuli and materials

The stimuli consisted of a 'basic' gender neutral face image, superimposed on randomly generated noise patterns , which yields a variety of stimuli (see Figure 1). The gender neutral base image was obtained from the Karolinska Institutet face database (Lundqvist, Flykt, & Öhman, 1998), which is a collection of photos depicting 70 individual expressing different emotions. The stimuli set consisting of 1000 images were created using the 'RCICR-package' in R (Dotsch, 2018) created by (Dotsch, 2016). The task was built using the online experiment-building tool Gorilla (Gorilla, 2018). The task included informed consent, as well as a questionnaire consisting of the participant number, age, gender and mood of the participant.

Mood was assessed by the question: “how are you feeling?” on a 7-point likert scale, from “1= extremely bad” to “7= extremely good”, where 3 indicates a neutral mood. Five hundred forced choice trials were designed for true and ideal self-image creation tasks each. Single trials consisted of two stimuli, the one on the right always containing the inverse noise pattern of the original one on the left. Same stimulus set was us ed for both tasks, although order of presentation of trials was randomised across participants. Classification images were created by using the R package “RCICR”.

For the recognition task, Microsoft PowerPoint was used to present the true and ideal CI’s to the participants. Six (three at the top, three at the bottom) images were presented on a screen. The images were 9 cm^2 each. A 18.9 inch (48.1 cm) screen with a 1280×1024 resolution was used. The correct CI was on a random location and the other five CI’s were randomly selected from the other participants’ CI’s. During the interview, the CI’s were enlarged on the screen and singled out from the 5 other CI’s. These images were between 14 and 16 cm^2. Notes were taken by the experimenter. Additional online questionnaires, presented with Google Forms, were the CES-D scale (Radloff, 1977) and Rosenberg self-esteem scale (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). CES-D scale has been demonstrated to be a reliable and valid measure, with a Cronbach’s alpha value ranging between .80 and .95 (Hunter et al., 2003; Radloff, 1977).

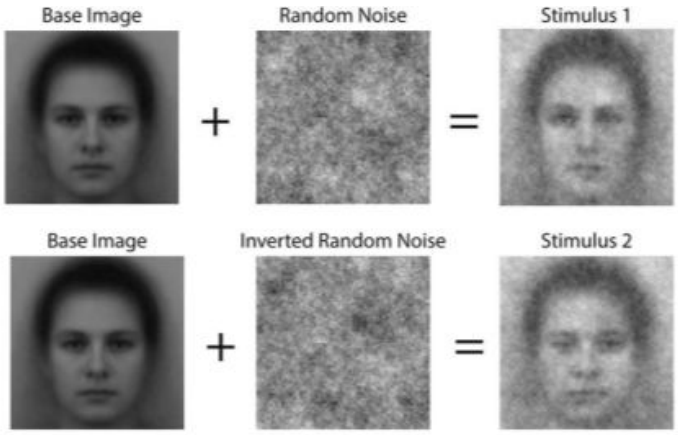


Figure 1. Construction of stimuli (Brinkman, Todorov & Dotsch, 2017).

Procedure

Upon arrival to the laboratories of Utrecht University, the experiment tasks were explained to the participants. The participant was handed two sheets (general explanation regarding the experiment and informed consent). These forms were administered in Dutch to native Dutch speakers and in English to non-Dutch speakers, although the experiment itself was in English. The experiment started when the experimenter took the signed consent form and left the laboratory where the participant completed the experiment alone. The participants additionally filled in a computerized consent form which was followed by the questionnaire. Age, gender and mood information was obtained. Next, the reverse correlation task was conducted after a single practice trial. A trial consisted of the presentation of two stimuli with opposite noise patterns. The participant selected the image with the cursor that best conformed to the question posed above the pictures. A thousand of these trials were held, in line with Brinkman and Kennis (2017). The first 500 trials were presented with the question: “What image reflects best how you see yourself?” aimed at creating the CI representing true self-image. The second 500 trials were presented with the question: “What image reflects best

how you would like to be?" for creation of ideal self-image. True self-image creation task was always presented before the ideal self-image creation task, since the recognition of the true CI bears more importance for our research purpose. The reason for this was wanting to eliminate distorting effects of fatigue in the creation of true self-image. After the experiment was completed, the noise patterns of the images chosen by the participants were averaged separately for each half of the trials in order to create two CI's, true and ideal.

In two to four weeks, the participants were invited to the laboratory for a second time for the self-recognition task and the interview. The participants were presented with two recognition tasks; first for true and later for ideal generated self-image, as in the original study. Both tasks followed the same procedure: the generated image was selected out of six different CI's presented on a computer screen. The participants were asked to pick the image that they thought was theirs. If they had picked the wrong CI, they could pick again until they picked the right CI.

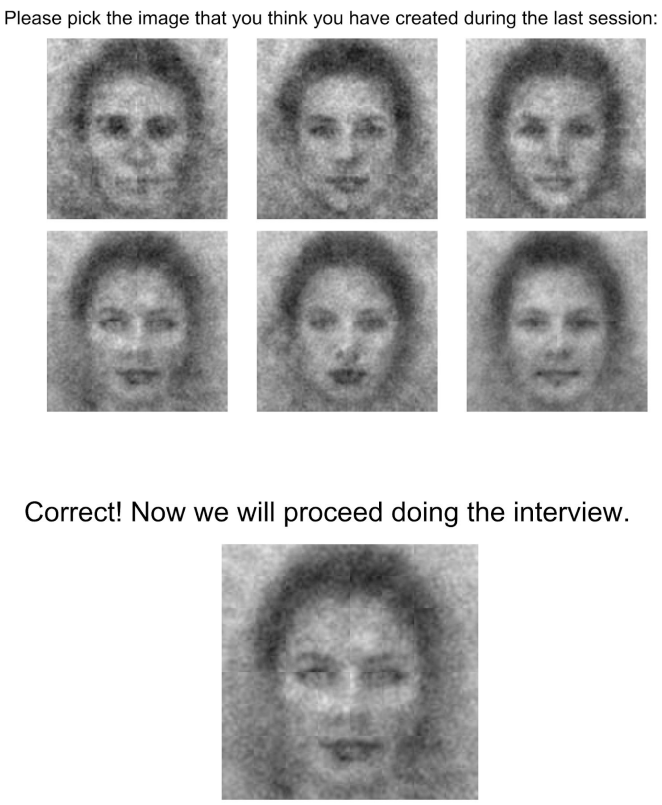


Figure 2. Recognition task.

Once the participants had selected the right CI, the experimenter proceeded to the interview about the CI that they had just picked (see Appendix 1 for the complete interview). These mainly involved questions comparing the participant to the CI. In the last part of the interview the participants were presented with the true and ideal images on the same slide. Questions regarding the comparison of the two CI's were asked. The interviews were not recorded but the experimenter took notes on a laptop during the interview. The interviews were held in Dutch for native Dutch speakers, and in English for non-Dutch speakers. Two to four weeks following the interview, the participants were sent the additional online questionnaires by email.

Statistical Analyses

An analysis plan was pre-registered on the Open Science Framework (Yilmaz, Verspui, Brinkman, 2018).

Confirmatory analyses. The first step of our analysis was checking the raw data for outliers on the aforementioned dimensions (age, response time, and left/right bias). The mathematical definition of an outlier was determined preceding the analysis. The raw data regarding the true and ideal CI creation was controlled individually. The designated age limit of 18-65 years followed the procedure of the original study. In order to exclude extremely fast responding participants, response times across trials were averaged for each participant. The exclusion criteria for a participant was having an average response time that is smaller than three standard deviations below the grand mean of response times across all participants. In this way, aimed preventing the results to be contaminated by uninterested participants. The participants with higher than average response times was not excluded, since taking more time than average to evaluate the faces does not necessarily interfere with the accuracy of the results. In addition, if a clear left/right bias is detected, defined as clicking the same button at least hundred times in a row, the participant would be excluded.

The true and ideal CI's for the remainder of the participants were then created by averaging the noise patterns for chosen images, resulting in two CI's for each participant. These images were used for the self-recognition task. After these participants have completed this task, our data consisted of the trial number in which each participant recognized their own image. The observed frequency distribution of CI recognition on six possible trials was plotted. We compared this observed frequency distribution to an expected frequency distribution (that

would be observed if there were no effect in the population) by means of a goodness of fit Chi-square analysis. This was done separately for true and ideal self-images. Effect sizes were calculated as well.

Exploratory analyses 1. The raw data was obtained from the additional study (Brinkman & Kennis 2018). This data included the CES-D score of the participants, as well as the independent depression ratings of the participants' CI's. Outliers were not excluded, in order to capture the realistic diversity of the scores and being able to account for the possible implications of this variability. After checking the data for assumptions (normal distribution, linearity of relationship, homoscedasticity), a Pearson's correlation test was conducted and the effect size (r^2) was calculated. The following step was splitting the CES-D scores from different percentile points to create alternative sets of data. These arbitrary cut-off points included 25th, 33rd, 50th, 66th, and 75th percentiles. Since we did not have specific hypotheses, these conventional cut-off points were selected.

Additionally, CES-D scores equal to and greater than 16 were segmented. The score of 16 was designated, as the literature suggests the diagnostic relevance of this point as a redflag for clinical depression (Radloff, 1977; Kohout, Berkman, Evans, & Cornoni-Huntley, 1993; Beekman, Deeg, Van Limbeek, Braam, De Vries, & Van Tilburg, 1997). This score points to symptoms of depression that require further clinical assessment. Former studies found meaningful results using this cut-off point (Freeman et al., 2006). Over these intervals of interest, we ran Pearson's correlations. The effect size of these correlations were calculated. Observed effect size values were compared to the original effect size value (calculated from the whole data), to spot any increase.

Exploratory analyses 2. Additionally, outcomes of the interviews were explored both quantitatively and qualitatively. Trends that were observed while interviewing the participants and analysing the interview notes were described and their implications were assessed. We focused on comparing participants' reactions to true and ideal images, as well as how strongly participants generally react to the images. In addition, statistical analyses were conducted regarding some questions of the interview data. This included translating some of the data into numbers. The amount of quantitative analyses were restricted, since the sample sizes become relatively small for conducting Chi-square analysis. Conducting statistical analyses with a small sample size would result in power and effect size values that are not reliable. Pearson's correlations between mood of participants, rated mood of true CI and ideal CI were computed.

Results

The analyses were conducted on IBM SPSS Statistics 24 and Microsoft Excel 2016.

Confirmatory Analyses

A Chi-square goodness of fit test was conducted to examine whether the participants had successfully recognised their true self-image. Assumptions for Chi-square goodness of fit test (independence of observations, mutual exclusivity and normal distribution of errors) were satisfied. The results revealed, that participants' recognition rates significantly deviated from chance (χ^2 (5, N = 31) = 28.79, p < .01., w = .96). Recognition rate on the initial trials were higher than expected, whereas on latter trials recognition rate was less than expected (see Table 1). Recognition rates of ideal self-images also yielded significant results (χ^2 (5, N = 31) = 57.80, p < .01., w = 1.37). The participants identified their ideal self-images most frequently on the first trial, recognition rate decreased with increasing trial numbers (see Table 1). For true

self-image, 48.39 percent of the participants recognised their image on the first trial, and 87.10 percent of the participants recognised their image within the first three trials. For ideal self-image, 64.52 percent of the participants took one trial to recognise their self-image, and 90.32 percent of the participants recognised within the first half of the trials. These results are displayed in a barcharts in the Tables and figures section (see Figure 1 and 2).

Exploratory Analyses 1

The obtained data on CES-D scores (M = 14.33, SD = 9.98) and independently assessed depression out of five (M = 1.94, SD = .59) was checked for assumption violations. Assessed depression data was normally distributed and contained no outliers. On the other hand, CES-D data was not normally distributed, as indicated by a Shapiro-Wilk test ($p < .01$). CES-D data also contained one outlier (CES-D score = 57.00). This outlier was not excluded from the analysis, as determined by the analysis plan, in order to capture the realistic variability in the scores. The rest of the assumptions (linearity, homoscedasticity and independence of observations) were satisfied.

A Pearson's correlation test showed that CES-D scores and assessed depression scores had a weak positive correlation ($r(128) = .18$, $p < .05$, $r^2 = .03$, two-tailed). Further exploration of the data revealed that correlating the same variables with an exclusion criteria of CES-D scores below 16 (which also corresponds to the 66th percentile) resulted in a stronger correlation ($r(43) = .33$, $p < .05$, $r^2 = .11$, two-tailed). When only participants with CES-D scores equal to and above the 25th (CES-D = 8.00), 33rd (CES-D = 9.00), 50th (CES-D = 12.00), and 75th (CES-D = 18.25) percentiles were included, no relationship between the variables was observed (all ps > .05). A scatter plot of the original correlation, as well as a plot for the correlation with CES-D

scores of 16 and above are displayed in the Tables and figures section (see Figure 3 and 4 respectively).

Exploratory Analyses 2

During the interviews, some patterns were observed. First, almost all of the participants found their ideal CI to be better-looking and happier than their true CI. Hence, the images that the participants were confronted with were able to display how the participants' current state did not perfectly match what they strive to be. There was a great variance observed in how participants conceptualized their ideal self-image. Some participants said, that the ideal CI really reflected how they wanted to look like. Others acknowledged that the ideal CI was a perfected version of how they actually looked. However, they also stressed, that they were happy with their current looks and even though the ideal CI looked objectively better-looking they would not want to become somebody else. A number of participants thought, that the ideal CI seemed like a more mature and grown up version of their true CI. It was also the case, although rarely, the participant found their true CI happier or prettier.

We also observed a variance in how strongly the participants reacted to the images. Some participants reacted very strongly to their images and remarked their concerns on improving their personality characteristics. On the other hand, another subset of the participants were indifferent to the images and underscored that they were not affected by them. Moreover, a lot of participants reported finding the pictures weird-looking, blurry and vague. Because of this, they found it hard to extract any physical or social information from them. However, many participants did seem to attribute their own personal characteristics onto the images. These were at times characteristics of the images that were not objectively observable to the experimenter.

These characteristics were imagined by the participants to be conveyed by the CI's expression when looking at the images. This was especially observed when asking the participants to describe the person they saw in the image, as if it were a real person. When asked whether the participant thought that these characteristics also reflected something of themselves, some participants who gave a vivid description said yes. It was also the case, other participants did not think their vivid descriptions matched who they really were. These tended to be the participants who did not react strongly to the CI's.

The participants who commented that they identified with the images generally thought they shared characteristics with the person depicted in the true CI. Conversely, participants who did not identify with the images, tended to emphasize their personal characteristics that differed from the person visualised on their true CI. Most of the participants, regardless of how much they identified with the images, accented that seeing those images made them reflect onto how they see themselves and that self-reflective thinking was interesting in itself.

Although the participants generally highlighted that their mood during the experiment matched the rated mood of the outcome images, statistical tests did not confirm this. Mood during the experiment (M = 5.03, SD = 1.02) was not related to self-rated mood (M = 3.09, SD = .81) of the true self-image ($r(29) = .27$, $p > .10$). It was neither related to self-rated mood (M = 3.58, SD = .75) of ideal self-image ($r(29) = -.32$, $p > .05$). Additionally, the rated mood of true and ideal self-images were not related ($r(29) = -.28$, $p > .10$).

By posing a question on what aspects of the images the participants concentrated on during CI creation task we investigated the strategy of the participants in creating their self-images. The question was as follows: " Have you concentrated more on the physical

properties or the psychological properties as you selected the pictures during the first session?". For the true CI creation, fourteen participants reported considering both physical and psychological properties. More importantly, fourteen participants focused only on physical properties and thus not at all on the psychological properties of the images. Three participants concentrated only on psychological properties. For the ideal CI's twelve participants focused only on physical, five participants only on psychological and fourteen participants on both of the aspects.

We aimed at statistically analysing our data to see if the used strategy affected recognition rates. However, a Chi-square test of independence could not be conducted with an adequate level of power, due to our limited sample size. The expected counts were very small, limiting the reliability of our results. Such a small sample size would require a very high effect size in the population to detect any effect. However, viewing raw data and reflecting on the interviews, one can see that using a physical strategy and mixed strategy led to similar recognition rates. These participants recognised their CI on the first trial most frequently, and the frequency decreased as the trial number increased. On the other hand, the participants with a psychological focus on true CI creation didn't show this pattern. One participant recognised their true CI on the last trial, one on the fifth trial, and another on the second trial. Hence, for true CI's there was a trend towards psychological focus resulting in somehow less accurate recognition compared to physical and mixed focus.

We additionally observed a trend of interaction between strategy and recognition rate for type of CI. Psychological focus yielded a better recognition rate when used for ideal CI's compared to true CI's. Although psychological focus for true CI's caused participants to

recognise their images on later trials, this strategy gave way to relatively more accurate recognition for ideal CI's. Three participants with a psychological strategy recognised their ideal CI on first trial, one participant on third and one participant on the fourth trial.

Discussion

The current study investigated the validity of reverse correlation in creating visual representations of true and ideal self-images by inquiring the recognition rates of these images, following the methods of Brinkman and Kennis (2017). We hypothesised that more than fifty percent of the participants would recognise both of their CI's on the first trial. Additionally, first three trials (recognising the correct image after one, two or three trials) were expected to yield greater recognition rates than the last three trials (recognising the correct image after four, five or six trials). Ideal self-images were recognised on the first trials 64.52 percent of the time. Thus, confirming our alternate hypothesis; over fifty percent of recognition rate in the first trial. True self-images, however, were recognised only 48.39 percent of the time on the first trial. Therefore, we failed to reject our null hypothesis regarding recognition of true CI's on first trial. This hypothesis might be based on a criterion that had been too strict. In addition, effect size might be a better indication of the validity of self-images created by reverse correlation. In the confirmatory analyses section we will elaborate further on what conclusion we should draw from this result. The first three trials yielded higher recognition rates than the last three trials for both type of CI's, in line with our hypotheses.

Another relation we investigated was a possible stronger correlation between CES-D scores and assessed depression as the CES-D scores increased. We hypothesised that designating higher intervals of CES-D scores (25^{th} , 33^{th}, 50^{th} 66^{th} and 75^{th} percentile) would

increase the strength of the relation between assessment and CES-D scores. The clinically relevant point of 16, which is also the 66th percentile, resulted in a stronger correlation with an increased effect size value. Additionally, our secondary exploratory analyses showed a pattern of more positive ideal CI's compared to true CI's. Our findings regarding the interviews will be elaborated in the section for exploratory analyses 2.

Confirmatory Analyses

Except for the recognition percentage of true self-images on first trial, all hypothesis could be confirmed by the results. The first hypothesis might have been based on a criterion that is too strict for recognition rate (greater than exactly fifty percent recognition on the first trial). Additionally, the finding of 48 percent recognition rate on the first trial does not differ from our criterion of 50 percent very much. Therefore, it might be invalid to conclude that reverse correlation is in fact not a valid method for assessing self-image. Besides, the obtained effect sizes might be a more credible way of scrutinizing the validity of the reverse correlation method for self-image, and might therefore have been a better criterion to base the hypothesis on. The obtained effect sizes of the significant Chi-square tests were $w = .96$ and $w = 1.37$ for true and ideal self-images respectively, which are both considered to be very large effect sizes. A conclusion that can be drawn from these results is, that the effect is actually high in the population, and that effect size might be a more accurate measure of the validity of the reverse correlation method in creating self-images. In other words, this would mean that reverse correlation is able to create an accurate approximation of a person's self-image, which is distinctive and recognisable when presented amongst other images created by the method.

The fact that our null finding diverges from the original findings by Brinkman and Kennis (2017) with a sixty percent recognition rate on the first trial, can be accounted for by several characteristics of our study that differ from the original study. The CI's that were used in the recognition task of the study-to-be-replicated were not matched to the gender of the participant. Half of the CI's were feminine and half were masculine for every participant, thus not all CI's corresponding the participants' gender. One could argue, that this means the probability of picking the right CI by chance is actually reduced. In this replication, the additional CIs' gender were matched to the gender of the participant. This means that if recognition is facilitated by gender, the recognition task in the original study was easier than in the replication done within this thesis. The rationale behind deciding to present gender specific powerpoints was driven by the remark of our first participant. They indicated that, their strategy for picking the CI was first eliminating all the males on the powerpoint and afterwards picking between the three female pictures that were left. Since this increases the probability of picking the right CI at chance by 50 percent, we decided to solve this problem by preparing gender specific slides. The recognition rate on the first trial of this study was close to 50 percent for true self-image (60 percent on the original study) and over 60 percent for the ideal self-image. It seems like, despite the increased difficulty of the task, the participants were still able to recognise their CI's with frequencies that do not differentiate from the original study substantially. We can then conclude that our method is actually less sensitive (as gender is held constant), but is more specific, because even when presented with same-gender CI's, the participants are still able to pick theirs almost as well as when gender varies.

Because of this attribute of our study, it might not be considered to be a complete replication. However, this could be viewed a strength of the study, since it gave us more insight into the capabilities of the reverse correlation method. Even when the task was rendered more difficult for the participants, we still obtained high effect size values. These results show us, that reverse correlation captures more personal properties of the participants', which are recognisable beyond their mere gender.

Another aspect regarding the completeness of the method is the ability to capture ethnic diversity. After finishing the CI creation task; the first participant, who identified as Asian, reported that she could not relate to the pictures as much. This was because the images in the reverse correlation task had a Caucasian base image. She mentioned, that if the pictures would have been more Asian looking to begin with she would have been able to make a more accurate representation of herself. She remarked, that in the recognition task she was mainly able to pick the right CI because this was the only Asian looking face. Only one non-Caucasian participant was recruited for this study, so the results are probably not strongly affected by this issue. However, this is a limitation of the study. Although on one hand, ethnicity was somehow captured by reverse correlation. On the other hand, the recognition rate was possibly affected by the fact that the additional CI's presented to the participant were clearly Caucasian looking. This way it might have been fairly easy for the participant to recognise their image, since their CI was the only Asian looking image. This aspect should be kept in mind for future research; just as the base image was made gender neutral, the base image can also be neutral to different ethnicities. Alternatively, different base images can be created for different ethnic backgrounds,

that might result in images that are easier to relate for non-Caucasian participants. Ethnicity can also be held constant when testing with different samples.

The sequence of CI creation was designated as true followed by ideal. The rationale behind this was eliminating the possible contaminating effect of fatigue. However, even though participants created their true CI's before the ideal one, recognition rates did not differ significantly, and in fact ideal CI's were recognised more frequently on the first trial (see results section). This might indicate that fatigue effect does not contaminate the outcome within a period of one hour, possibly with the help of frequent breaks. Alternatively, it could mean that fatigue effect was indeed present, and ideal CI's were actually easier to recognise. In this case, we would expect recognition rate of ideal CI's to be decreased. Then, ideal CI's would have significantly higher recognition rates than true CI's in the absence of the fatigue effect. Hence, in the presence of fatigue the recognition rates of true and ideal CI's might have been equalised. It would be sensible for future studies to counterbalance the order of true and ideal creation tasks to capture possible effects of fatigue.

Exploratory Analyses 1

The effect size of the original study was quite high and it differed greatly from the additional study that had a very low effect size. There are some limitations that stem from the differences between these datasets, which make it hard to converge these findings. One aspect that differentiates the two sets of data is that original data was on assessed positivity scores, whereas the additional data was collected regarding assessed depression. Differential findings might be explained by different connotations of participants of depression and positivity. Additionally, the original study showed the true and ideal self-image next to each other when

comparing their positivity. On the other hand, the additional study showed different images individually in randomised order and later subtracted the assessment scores. The higher effect size of the original study might be caused by this comparison method, that is arguably more reliable, because raters are able to visualise both images at the same time, while comparing.

Above the clinically relevant cut-off point of a CES-D of 16, the correlation had a higher effect size than the effect size obtained from correlating all the data, hence a stronger association between depressive symptoms and assessed depression. Our prediction is that this pattern is observed especially due to the clinical relevance of this score (Radloff, 1977; Husaini et al., 1980). The relation is presumably too small to capture by presenting the images independently when depressive symptoms are not excessive. However, as the depression score of the participant increases to a diagnostically significant level, the discrepancy becomes evident enough, so that it can be recognised by independent raters even when true and ideal self-images are presented on different on time points.

This finding adds to the accumulating evidence of 16 being a clinically relevant CES-D score. Additionally, the fact that a stronger correlation was found as the CES-D score increased, indicates that depression symptoms are actually recognisable in the CI's created by reverse correlation. Reverse correlation can be a valuable addition to currently available diagnostic methods, by providing a visual tool. However, this method might not be an ideal tool to differentiate depressive symptoms in a healthy sample. As depressive symptoms become clinically alerting, CI's might become more robust and reliable predictors of depressive symptoms. It could be useful for future research to directly compare samples of depression patients and healthy controls to further assess the diagnostic credibility of the reverse

correlation method. Moreover, it might be more reliable for future research to use an independent sample of clinical psychologists in assessing depression conveyed from the images. If it is indeed diagnostically relevant, the ultimate users of this method will be clinical psychologists.

Interestingly, the positive relationship observed above the score of 16 disappears when we increase the cut-off point to the 75th percentile. This pattern might arise from the reduced sample size (n = 32 from 75th percentile, instead of n = 45 for CES-D >= 16) and thereby reduced power of the data. Future studies can try to replicate these findings only on patient populations, by displaying the true and ideal CI's in the same screen while the depression is assessed. These studies can aim for high sample sizes to increase power and display more robust findings. In addition to this, former literature also discussed other CES-D scores that might be of clinical relevance. Scores ranging from sixteen to twenty are also addressed, increasing scores are discussed as possible more robust indicators of depression (Husaini, Neff, Harrington, Hughes, & Stone, 1980). For this reason, focusing on a patient population with a high sample size will be useful to assess the correlation, between CES-D and assessed depression, with a high power value. Differential CES-D scores can then be more sensitively spotted if the required sample size is achieved.

Another important detail regarding diagnostic applicability of reverse correlation is whether the outcome image is affected by the mood of the participant. If a depressive looking image reflects only a transient state of sadness, and not a permanent mindset of depressiveness, the CI's can be misleading for a diagnostic interest. In order to assess how much the mood of participant affected the rated mood of the CI we ran statistical tests. We observed a discrepancy

between self-reports and statistical tests on how much the mood of the CI's matched mood during the experiment. Whereas participants reported they had a similar mood to the rated mood of their CI's, the statistical tests did not confirm this correlation. This can be accounted for by several reasons. First of all, mood did not vary too much and a lot of the participants indicated having a neutral mood during the experiment. Thus, our setting might not have been sensitive enough to capture differences in the initial mood, as participants are mainly neutral and concentrated during the experiment.

Moreover, actual mood score and retrospective report might tap on different things. Asking participants to retrospectively reflect onto their mood they had during the experiment might have obscured how they felt when they came to the laboratory. Since the experiment took approximately one hour, mood possibly tended to neutralize during the experiment and when participants reflected onto a period of one hour they reported feeling neutral. However, the mood rating was taken prior to the experiment and possibly signified the mood before the experiment rather than the actual mood during the experiment. It might be helpful for future studies to insert a mood question in the end and in between both the creation tasks to be able to capture the actual mood during the experiment. Additionally, the actual effect of mood on CI creation should be more thoroughly assessed, since this is important for the diagnostic applicability of the CI's. An idea would be taking mood as a covariate while correlating scores of CES-D and assessed depression.

Exploratory Analyses 2

We frequently observed a discrepancy between true and ideal CI's in terms of looks and happiness. Many participants (n = 8) claimed their ideal image looked more confident than their

true self-image. Even though this is not the majority, it protruded as many participants reported their self-image to be more “attractive”, “extraverted”, and “happy”. It can be said that the true self-image was generally rated better on several positive characteristics. The ability of reverse correlation to capture this in a visual representation might be of therapeutic value, as our participants generally found it striking to visualise both of these images and compare them with each other. Some participants remarked, that even though they did not completely identify with the images, the interview setting and being confronted with a visual input that bears cues about their mental state made them contemplate how they really see themselves. In a therapeutic setting, existence of a visual tool might facilitate self-reflective thinking and encourage the patient to acknowledge problems regarding self representation.

One factor to explain the variance in reactions to the images might be, that some participants seemed to be uncomfortable with the blurriness of the images in the creation task. This presumably caused the participants to lose interest in the task. One of those participants also remarked explicitly that they did not have much faith in the technique due to the strange nature of the images. Also, some participants thought they did not look like any of the images in the trials. They found it hard to find common aspects between themselves and images. Consequently, they did not react very strongly to the outcomes either. On the other hand, participants who were more enthusiastic about the outcomes and the technique seemed to identify more easily with the CI’s.

The latter subset of the participants gave more elaborate answers to the interview questions. Furthermore, when the participants identified more with the images, we realised they reflected their own characteristics onto the images beyond objective physical descriptions.

These characteristics were not necessarily visible to the experimenter, but were picked up by the participants in the process of their self-reflective thinking. This might especially be useful in therapeutic settings as projecting could be a way for the people to open up about themselves. The CI can be used as a visual guideline containing a representation of how they view themselves (not only physically but also psychologically). Identification with the CI by the patient might be a prerequisite for this personal reflection onto the image and finding more in the image than is objectively visible. This becomes more pronounced when considering that participants who identified stronger with the CI's found that the description of the person in the image (described by themselves) was also true for their personality. Conversely, participants who did not identify with the image very much, emphasized the differences between themselves and the person in the image. This finding is interesting, because it shows even in the absence of identification with the image, being confronted with a CI facilitates self-reflective thinking and emphasizing the distinguishing characteristics of the individual that differentiates from the CI.

One important question on the interview was about the strategy the participants used as they created the CI's. We decided to investigate this, departing from participants' comments emphasising the physical properties of the images presented during the CI creation task. Our rationale behind investigating this, was the questionable therapeutic validity of an image that has been created solely on how physically similar the facial characteristics are to the individual. We assessed the strategy by asking whether the participants concentrated more on physical or psychological properties as they performed the reverse correlation task. If the participants concentrated solely on physical properties, it could be harder to capture any emotional aspect of the individual by looking at the CI's. Which would decrease the diagnostic or therapeutic

relevance of the images. Thus, we concluded that it was a prerequisite that the images would capture psychological properties of the self, to be used as a clinical tool.

Our results showed, only three participants focused merely on psychological properties while they created their true CI. This focus did not yield very high recognition rates, possibly because the participants could not identify with the images that did not physically resemble themselves, since the image probably only displayed some psychological state. Five participants focused only on psychological properties while creating the ideal CI's. Three out of five of these participants recognised their ideal CI on the first trial. This might indicate that participants selected a more physically similar proxy of their mental image for true self-image. On the other hand, participants might find it easier to relate to an ideal image that conveys positive emotions and does not necessarily mimic how they look. We advise replication with higher sample sizes, in order to be able to achieve a meaningful power level to conduct reliable statistical tests regarding our hypothesis. It would also be useful to manipulate strategy in order to see the effects on a more controlled study. The clinical relevance of this strategy analysis is not only to portray whether participants take into account psychological variables as they create the CI's, which is a prerequisite to depict the psychological self in the image. But also, strategy analysis taps the importance of creating a self-image with which the patient can identify and reflect on. Variables that affect how strong this identification is should therefore be addressed. When it is more clear what strategy is best for creating a relatable CI, an instruction for the participant can be implemented into existing therapies to have an optimal result.

General Discussion

The current replication study can be considered as getting one step closer to validating reverse correlation as a means to create self-images. The effect size values we have obtained are considered to be very high, thus indicating our participants were generally successful in recognising their CI's. Departing from our experience with the interviews, we can confidently conclude, that reverse correlation captures at least certain personal facial characteristics which make it easier for the participants to recognise themselves. Follow-up studies might consider designing more sensitive recognition tasks. Although, we can come to the conclusion the CI's are generally recognisable, we are not aware how distinctive those images are. For instance, when presented among a higher number of alternative CI's would the participants still be able to recognise their CI's as accurately?

It might still be early to conclude about the diagnostic relevance of the CI's in the whole population. However, our study found a meaningful relation between CES-D scores and assessed depression on an at risk population. This finding needs to be scrutinized in the future with higher sample sizes, as well as with different cutoff points, in order to conclude more confidently about the diagnostic potential of images created by reverse correlation.

A visual approximation created by reverse correlation could be an addition to therapies because the patients can physically view their self-image, and also the difference between their true and ideal self-images. Upon reflecting on their self representation within evidence-based therapies like COMET or CBT, a visual feedback might aid the participant in gaining more insight into their self-image than only verbal or written feedback. It might also help patients to acknowledge problems more easily, since a visual representation might be more confronting.

Even though a visual representation alone might not be very effective in improving symptoms of clinical disorders, it could still be implemented in existing therapies as an additional tool to give a visual proximation of the participants' self-image. In order to implement CI's in a clinical setting, however, more studies should be conducted focusing explicitly on clinical samples.

References

Anderson, B., Goldin, P. R., Kurita, K., & Gross, J. J. (2008). Self-representation in social anxiety disorder: Linguistic analysis of autobiographical narratives. *Behaviour Research and Therapy*, *46*(10), 1119-1125.

Beekman, A. T., Deeg, D. J. H., Van Limbeek, J., Braam, A. W., De Vries, M. Z., & Van Tilburg, W. (1997). BRIEF COMMUNICATION.: Criterion validity of the Center for Epidemiologic Studies Depression scale (CES-D): results from a community-based sample of older subjects in the Netherlands. *Psychological medicine, 27*(1), 231-235.

Bentall, R. P., & Kaney, S. (1996). Abnormalities of self-representation and persecutory delusions: A test of a cognitive model of paranoia. *Psychological Medicine*, *26*(6), 1231-1237.

Brinkman, L. & Kennis, M. (2017). Herkenning van een visueel zelfbeeld. *Unpublished.*

Brinkman, L., & Kennis, M. (2018). Graph and data from additional study.

Brinkman, L., Todorov, A., & Dotsch, R. (2017). Visualising mental representations: A primer on noise-based reverse correlation in social psychology. *European Review of Social Psychology*, *28*(1), 333-361.

Dotsch, R. (2016). rcicr: Reverse-correlation image-classification toolbox. *R package version 0.3*, *4*.

Dotsch, R. (2018). Reverse correlation using R. Retrieved from: http://www.rondotsch.nl/rcicr/

Dotsch, R., & Todorov, A. (2012). Reverse correlating social face perception. *Social Psychological and Personality Science*, *3*(5), 562-571.

Dotsch, R., Wigboldus, D. H., Langner, O., & van Knippenberg, A. (2008). Ethnic out-group faces are biased in the prejudiced mind. *Psychological Science*, *19*(10), 978-980.

Erkolahti, R., Ilonen, T., Saarijärvi, S., & Terho, P. (2003). Self-image and depressive symptoms among adolescents in a non-clinical sample. *Nordic Journal of Psychiatry*, *57*(6), 447-451.

Freeman, E. W., Sammel, M. D., Lin, H., & Nelson, D. B. (2006). Associations of hormones and menopausal status with depressed mood in women with no history of depression. *Archives of general psychiatry, 63*(4), 375-382.

Goldin, P. R., Jazaieri, H., Ziv, M., Kraemer, H., Heimberg, R. G., & Gross, J. J. (2013). Changes in positive self-views mediate the effect of cognitive-behavioral therapy for social anxiety disorder. *Clinical Psychological Science*, *1*(3), 301-310.

Gorilla. (2018). Retrieved from https://gorilla.sc/

Harpaz-Rotem, I., & Blatt, S. J. (2009). A pathway to therapeutic change: Changes in self-representation in the treatment of adolescents and young adults. *Psychiatry: Interpersonal and biological processes*, *72*(1), 32-49.

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A., & Lillis, J. (2006). Acceptance and commitment therapy: Model, processes and outcomes. *Behaviour research and therapy, 44(*1), 1-25.

Hunter, W.M., Cox, C.E., Teagle, S., Johnson, R.M., Mathew, R., Knight, E.D., Leeb, R.T., & Smith, J.B. (2003). *Measures for Assessment of Functioning and Outcomes in Longitudinal Research on Child Abuse*. Volume 2: Middle Childhood. Accessible at the LONGSCAN web site (http://www.iprc.unc.edu/longscan/)

Husaini, B. A., Neff, J. A., Harrington, J. B., Hughes, M. D., & Stone, R. H. (1980). Depression in rural communities: Validating the CES‐D scale. *Journal of community psychology*, *8*(1), 20-27.

Imhoff, R., Dotsch, R., Bianchi, M., Banse, R., & Wigboldus, D. H. (2011). Facing Europe: Visualizing spontaneous in-group projection. *Psychological science*, *22*(12), 1583-1590.

Imhoff, R., & Dotsch, R. (2013). Do we look like me or like us? Visual projection as self-or ingroup-projection. *Social Cognition, 31*(6), 806-816.

Kohout, F. J., Berkman, L. F., Evans, D. A., & Cornoni-Huntley, J. (1993). Two shorter forms of

the CES-D depression symptoms index. *Journal of aging and health, 5*(2), 179-193.

Korrelboom, K., Maarsingh, M., & Huijbrechts, I. (2012). Competitive Memory Training (COMET) for treating low self-esteem in patients with depressive disorders: a randomized clinical trial. *Depression and anxiety*, *29*(2), 102-110.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directed Emotional Faces – KDEF, CD ROM from Department of Clinical Neuroscience, *Psychology section, Karolinska Institutet,* ISBN 91-630-7164-9.

Mantilla, E. F., Bergsten, K., & Birgegård, A. (2014). Self-image and eating disorder symptoms in normal and clinical adolescents. , *51*(6), 1224.*Eating behaviors*, *15*(1), 125-131.

Paulhus, D. L., & Williams, K. M. (2002). The dark triad of personality: Narcissism, Machiavellianism, and psychopathy. *Journal of research in personality*, *36*(6), 556-563.

Paredes, A., Ludwig, K. D., Hassenfeld, I. N., & Cornelison, F. S. (1969). A clinical study of alcoholics using audiovisual self-image feedback. *Journal of Nervous and Mental Disease, 148(4),* 449-456.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied psychological measurement*, 1(3), 385-401.

Segal, Z. V. (1988). Appraisal of the self-schema construct in cognitive models of depression. *Psychological Bulletin, 103*(2), 147.

Shestyuk, A. Y., & Deldin, P. J. (2010). Automatic and strategic representation of the self in major depression: trait and state abnormalities. *American Journal of Psychiatry*, *167*(5), 536-544.

Shorten, C. A. (2017). Similarity Between Actual and Possible Selves and Its Relationship to Self-esteem.

van Driel, S. D., Leijenaar, A., & Kusters, J. (2017). *Prediction of Self Perception based on Dominance and Trustworthiness by using Reverse Correlation* (Bachelor's thesis).

Weaver, B. (2017). Assumptions/Restrictions for Chi-square Tests on Contingency Tables. Lakehead university - bweaver. Retrieved 22 March 2018, from https://sites.google.com/a/lakeheadu.ca/bweaver/Home/statistics/notes/chisqr_assumptions

Yilmaz, D., Verspui, M., & Brinkman, L. (2018). A Replication Study - Visualising the Implicit Self-Image. Retrieved from https://osf.io/6esrw/

Tables and Figures

Table 1

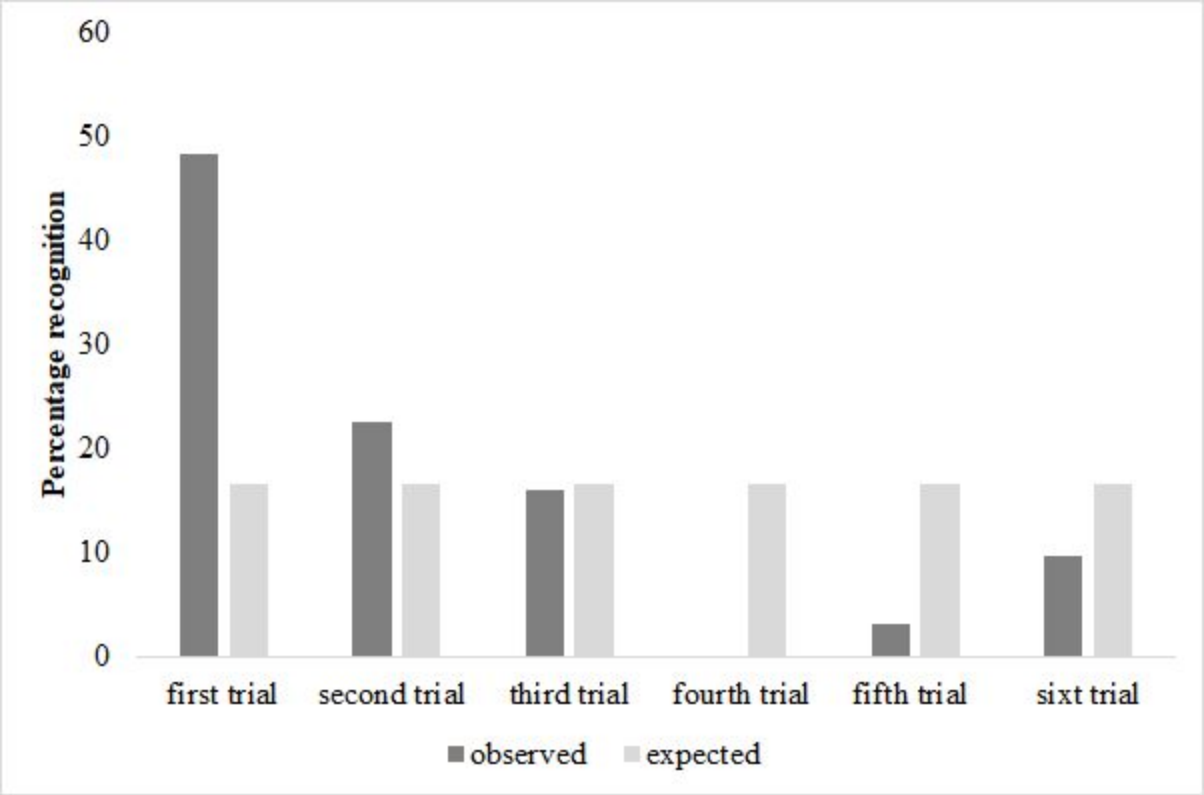
Self-Image Recognition Rates

Trial of accurate recognition	True Self-Image		Ideal Self-Image	
	Expected	Observed	Expected	Observed
First trial	5.17	15	5.17	20
Second trial	5.17	7	5.17	7
Third trial	5.17	5	5.17	1
Fourth trial	5.17	0	5.17	3
Fifth trial	5.17	1	5.17	0
Sixth trial	5.17	3	5.17	0

Note. All numbers constitute raw, non-standardized scores. The numbers denoted as "Expected" indicate the expected counts in the case that null hypothesis was failed to be rejected, thus the self-images were not recognised by the participants. The numbers under the "Observed" section show the amount of participants that recognised their self-images on the respective trial. The table demonstrates the high observed rates of recognition on the initial trials, pointing to the validity of the method in creating recognisable self-images.

Figure 1

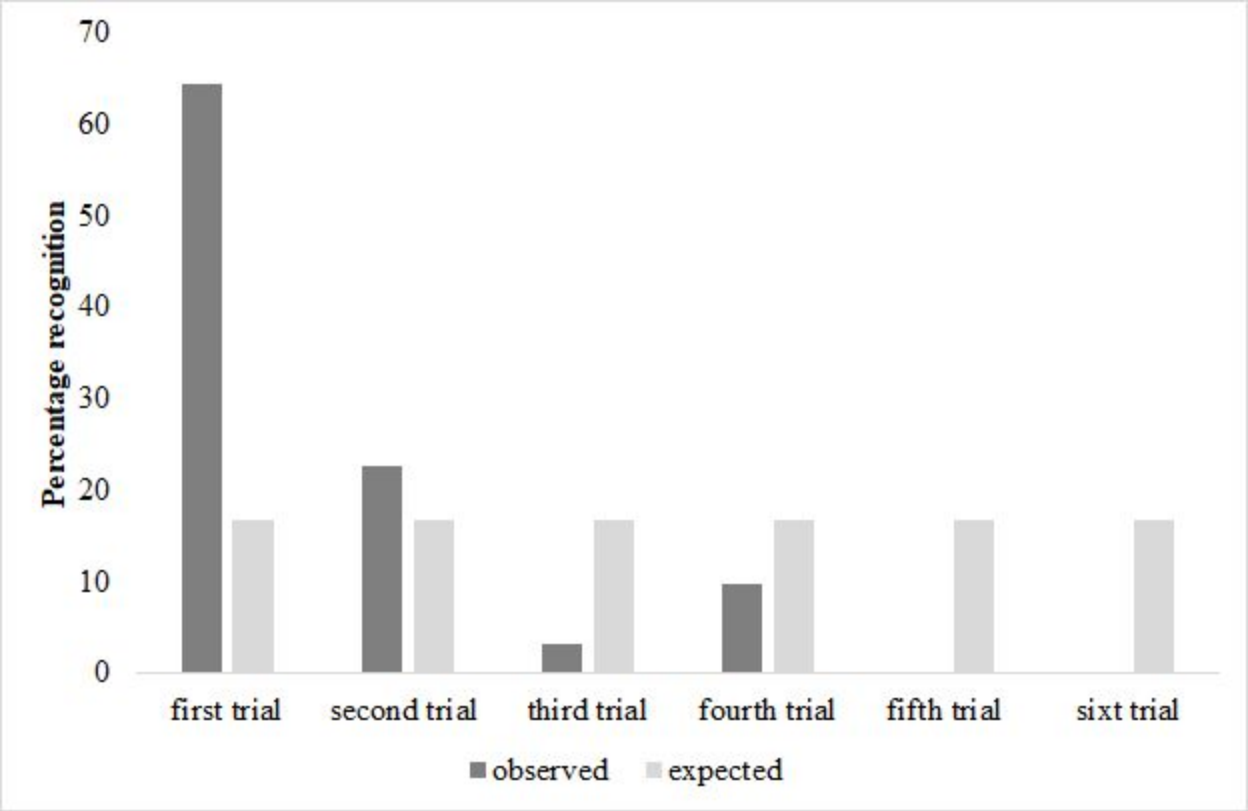
Recognition rates of the true self-images (in percentages).



Note. All numbers constitute raw, non-standardized scores. The x-axis displays the trials of the recognition task. The y-axis displays the percentages of how many participants recognised themselves on a certain trial for the true self-image. Both the observed and expected counts are displayed.

Figure 2

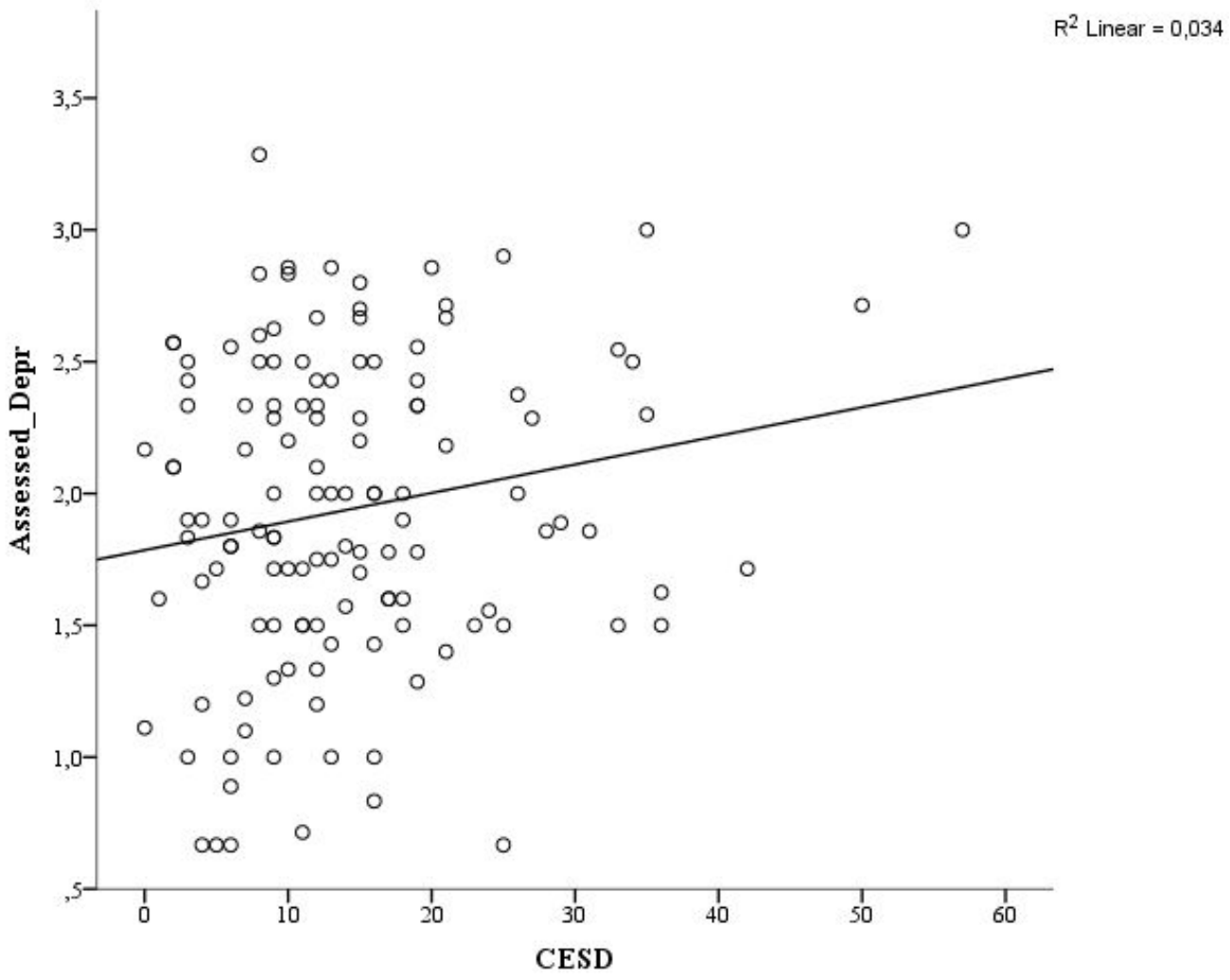
Recognition rates of the ideal self-images (in percentages).



Note. All numbers constitute raw, non-standardized scores. The x-axis displays the trials of the recognition task. The y-axis displays the percentages of how many participants recognised themselves on a certain trial for the true self-image. Both the observed and expected count are displayed.

Figure 3

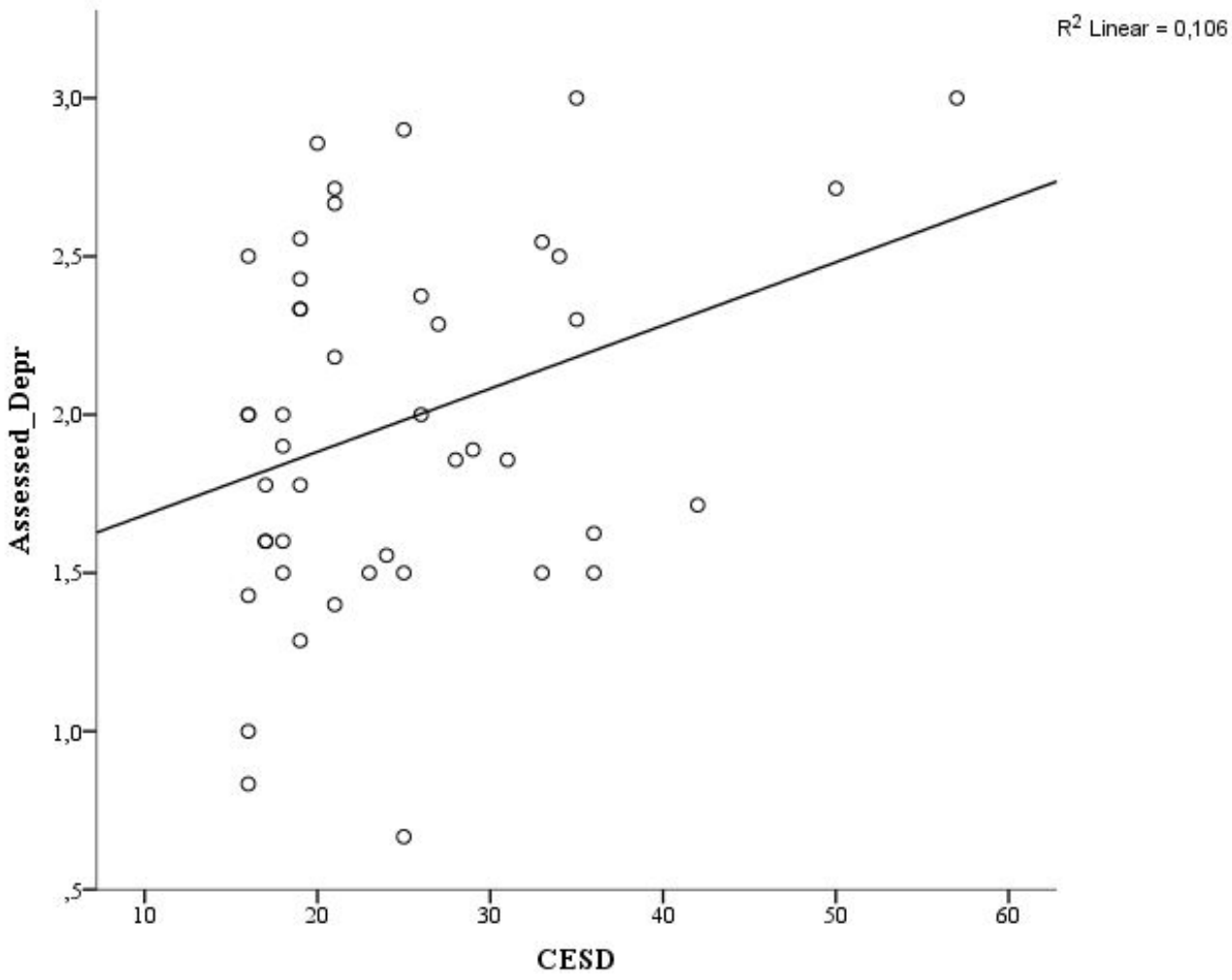
CES-D and Assessed depression correlation



Note. All numbers constitute raw, non-standardized scores. The numbers on the y-axis denoted as "Assessed_depr" indicate the assessed depression of the CI's by independent participants. The numbers on the x-axis denoted as "CES-D" indicate the participants' CES-D scale score. The data was obtained from (Brinkman & Kennis, 2018). The line indicates the regression.

Figure 4

CES-D and Assessed depression correlation cutoff 66th percentile (=>16 CES-D score)



Note. All numbers constitute raw, non-standardized scores. The numbers on the y-axis denoted as "Assessed_depr" indicate the assessed depression of the CI's by independent participants. The numbers on the x-axis denoted as "CES-D" indicate the participants' CES-D scale score. The data was obtained from (Brinkman & Kennis, 2018). The line indicates the regression. This is a correlation of the original data, cutoff at the 66th percentile, which corresponds to a CES-D score of 16 and above.

Appendices

Appendix 1

INTERVIEW TRUE CI

Now you see the image that you have created. We will now ask you some questions about the image. Some questions will be personal. If you feel uncomfortable answering certain questions, please let us know.

- What do you think about the picture? What strikes you the most when you see this image?

- Have you concentrated more on the physical properties or the psychological properties as you selected the pictures during the first session?

- Describe the characteristics of the person in the picture. What do you think this person is like?

- Do you recognize any of the characteristics that you just described as your own characteristics?

- What physical aspects of yourself, do you recognize in the picture?

- What psychological aspects of yourself, do you recognize in the picture?

- When looking at the face on this picture, what mood would you say this picture reflects? Is it positive or negative? 1 being very negative and 5 being very positive.

- With what valency word would you describe the mood of the picture? (e.g. happy, sad, angry, stressed, etc.)

- Is that the mood you were during the experiment?

- Do you think this image reflects your transient mood at the time of the experiment, or rather your permanent state of mind?

- How do you feel, seeing this picture and associating it with yourself?

INTERVIEW IDEAL CI

Now you see the image that you have created. We will again ask some more questions.

- What do you think about the picture? What strikes you the most when you see this image?

- Have you concentrated more on the physical properties or the psychological properties as you selected the pictures during the first session? Is it the same strategy as for the first, “real” self-image?

- Describe the characteristics of the person in the picture. What do you think this person is like?

- Do you recognize any of the characteristics that you just described as your own characteristics?

- Is this what you would like to be like?

- What physical aspects of yourself, do you recognize in the picture?

- What psychological aspects of yourself, do you recognize in the picture?

- When looking at the face on this picture, what mood would you say this picture reflects? Is it positive or negative? 1 being very negative and 5 being very positive.

- With what valency word would you describe the mood of the picture? (e.g. happy, sad, angry, stressed, etc.)

- Do you think this image reflects your transient mood at the time of the experiment, or rather your permanent state of mind?

- How do you feel, seeing this picture and associating it with yourself?

COMPARISON TRUE AND IDEAL CI

You now see the two pictures, the true and ideal self-image that you have created next to each other.

- Which one do you think looks more like you?

- What do you think are the similarities (between the pictures)?

- What are the differences?

- How does seeing these two pictures together affect you?

- Does seeing this give you more insight into yourself? Did you learn something about yourself from this experience?

- Do you have any additional comments, now that you see the two images together?

ADDITIONAL QUESTIONS

- We have now come to the end of the interview. Do you have any comments or questions about the experiment or the interview as a whole?

- Do you want to have your pictures sent to you?