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An intervention protocol proposal to modify the body image disturbance using Virtual Reality

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Abstract: A negative experience with one's own body has been theorized as a common antecedent of eating disorders (EDs). In fact, body image disturbance (BID) is considered a key factor in the development, maintenance and relapse of Anorexia Nervosa (AN). As yet, the mechanisms underlying this disturbance in body representation remain unclear. In this paper we present the study protocol of this novel Virtual Reality (VR) multisensorial paradigm to assess and treat BID. Participants will be asked to perform a real and virtual body size estimation task. Then, they will be assigned to one condition (experimental vs, control), and they will have to perform a task from 1st or 3rd point-of-view, in a counterbalanced manner. The "experimental" condition task consists of touching the real abdomen while looking at the virtual one. The "control" condition task consisted of making slow movements meanwhile looking at the virtual abdomen. Thereafter, participants will perform again the real and virtual body size estimation tasks. After ten minutes, they will perform the procedure from the other point-of-view (1st vs. 3rd). This protocol is intended to be an effective tool that allows the development of a more realistic corporal representation adjusted to the own body size.
Keywords: Body Image Disturbance, Virtual Reality, Body Size Estimation, Protocol.

Título: Propuesta de un protocolo de intervención para modificar la alteración de la imagen corporal mediante el uso de Realidad Virtual.

Resumen: La experiencia negativa del propio cuerpo es un antecedente común en los Trastornos de la Conducta Alimentaria (TCA). De hecho, las alteraciones de la imagen corporal (AIC) son un factor clave en el desarrollo, mantenimiento y recaída de la Anorexia Nerviosa (AN). Hasta el momento, los mecanismos que subyacen a las AIC son confusos. En este artículo presentamos el protocolo de un nuevo paradigma multisensorial de Realidad Virtual (RV) para la evaluación y el tratamiento de las AIC. Las participantes tendrán que realizar una tarea de estimación del tamaño corporal real y virtual, siendo posteriormente asignadas a una condición (experimental vs. control). Tendrán que realizar una tarea desde un punto de vista en 1ª y 3ª persona, en orden contrabalanceado. La tarea de la condición "experimental" consiste en tocarse la barriga real mientras están mirando a la virtual. En la condición "control" harán movimientos lentos mientras miran el abdomen virtual. Tras ella, volverán a realizar la estimación del tamaño corporal real y virtual. Transcurridos diez minutos, realizarán el procedimiento desde el otro punto de vista (1º vs. 3º). Este protocolo pretende ser una herramienta efectiva que permita el desarrollo de representaciones corporales realistas y ajustadas al propio tamaño corporal.
Palabras clave: Alteraciones de la Imagen Corporal, Realidad Virtual, Estimación del Tamaño Corporal, Protocolo.

Body experience alterations appear in various psychological problems, such as low self-esteem (O'Dea, 2012) or sexual difficulties (Wiederman, 2012). Moreover, a negative experience with one's own body has been proposed as a common antecedent of eating

disorders (EDs) (e.g., Channon, & DeSilva, 1985; Fairburn, 2008; Fairburn, Cooper, & Shafran, 2003). In fact, the disturbed experience of body weight and shape is a central diagnostic criterion of anorexia nervosa (AN) (American Psychiatric Association, 2013). Body image disturbance (BID) is considered to be a key factor in the development, maintenance and relapse of AN (e.g. Fairburn et al., 2003; Gledhill, Cornelissen, Cornelissen, Penton- Voak, Munafò, & Tovée, 2017; Keel, Dorer, Franko, Jackson, & Herzog, 2005; Killen et al., 1996; Stice, 2002; Stice and Shaw, 2002;).

As yet, the mechanisms underlying BID remain unclear. Nevertheless, there is an agreement in the scientific literature in regards to two different components which are theorized to be at the core of BID, and several authors posit that BID is characterized by a perceptual and an attitudinal-cognitive-affective component (e.g., Cornelissen, Johns, & Tovée, 2013; Dakanalis, Gaudio, Serino, Clerici, Carrà, & Riva, 2016; Frank, & Treasure, 2016). This conceptualization is strengthened also by a recent neuropsychological and neurobiological theory: the Allocentric Lock (AL) Hypothesis (Gaudio & Riva, 2013; Riva, 2011; Riva & Gaudio, 2012; Riva, Gaudio, & Dakanalis, 2014).

The AL posits that the bodily spatial experience involves the integration of inputs originated from two different reference frames: a real-time perception-driven frame (i.e., egocentric, first-person view) and the body memory (i.e., allocentric, third-person view) which is composed by abstract knowledge, beliefs and attitudes related to a person's own body (Riva, 2011). The AL hypothesis suggests that AN may be the result of a multisensory processing deficit in the way expected versus experienced body-related experiences are integrated. Specifically, this theory posits two possible impairments in AN multisensory processing: (1) an impairment in the ability to link interoceptive bodily signals to their potential consequences; and (2) an impairment in the ability to update the allocentric memory-driven experience of the body with new contents from the real-time perception-driven egocentric inputs (e.g., Riva & Gaudio, 2018; Riva & Dakanalis, 2018). Thus, eating disordered patients continue to negatively experience their body even after a significant weight loss, as in the case of AN.

In the last two decades, researchers have embraced virtual reality (VR) in order to integrate and extend the assessment tools and treatments for many psychological disorders. A recent meta-analysis reported that the highest number of studies have been conducted in anxiety disorders and stress-related disorders, showing the efficacy of VR in the treatment of panic disorder, phobias, stress management, and post-traumatic stress disorder (Riva, Baños, Botella, Mantovani, & Gaggioli, 2016).

Research on VR in EDs started in the late 1990s (Perpiña, Botella, Baños, Marco, Alcañiz, & Quero, 1999; Riva, 1997, 1998; Riva, Melis, & Bolzoni, 1997). VR appears particularly effective in studying, assessing and treating BID. In VR,

subjects can experience virtual avatars as if they were their own body; this phenomenon is called "embodiment" and it refers to the replacement of the physical body with a virtual one (Gutiérrez-Maldonado, Ferrer-García,Dakanalis, & Riva, 2017; Riva, Dakanalis, & Mantovani, 2015; Riva, & Mantovani, 2012, 2014). The possibility of developing human-like avatars that represent the body of the subjects and whose size and shape can be modified (e.g., Gledhill et al., 2017; Mölbert et al., 2018) enables them to embody their mental representations of body image (e.g., ideal body, perceived body). Through VR, it is possible to recreate BID and to integrate new information about one's body and to acquire different strategies to differentiate the cognitive and affective misperception of one's body from the real body (Aimé, Cotton, Guitard, & Bouchard, 2012).

Different techniques have been used to recreate BID or bodily illusion in VR (Perez-Marcos, Slater, & Sanchez-Vives, 2009; Serino et al., 2016; Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2009). In the present study we propose a new multisensorial VR paradigm to assess and treat BID. Female participants will be asked to recreate in VR their body representation (i.e., the perceived body). Specifically, participants will be able to choose between a wide range of 3D bodies the one that best fits their perceived body. Those women who will consider themselves as bigger or thinner than their actually size, will be asked to perform a multisensorial (visuo-tactil) task that will show them that their perceived body doesn't correspond to the real one. Therefore, we hypothesize that when participants will realize that their virtual body doesn't match with their real body, it will create an important doubt in their mind about the accuracy of their body perception. We hypothesize that as a consequence they will be more likely to admit their BID, and to develop a new, more realistic representation of their body. In this paper we present the study protocol of this novel VR multisensorial paradigm to assess and treat BID.

Method

Study design

It is a mixed design with 2 randomized inter-subject conditions (experimental vs control condition) x 2 intra-subject (egocentric vs allocentric perspective) x 2 intra-subject (pre vs post assessments).

Ethics

This trial received approval from the Ethics Committee of the Universitat de Valencia (Valencia, Spain) (6 November 2017), and it will be conducted in compliance with the study protocol, the Declaration of Helsinki, and good clinical practice. Data security/confidentially will be guaranteed, and all pertinent Spanish and European legislation on privacy will be observed and respected. The consent form will be explained and required from all participants. Important protocol modifications will be communicated to relevant parties (i.e., trial

participants, registries, journals, ethical committee, and researchers).

Eligibility criteria

The study will be conducted in a community sample of young women. The eligibility criteria are (1) being a woman, (2) being between 18 and 35 years old, (3) having a BMI between 18.5 and 24.99. The exclusion criteria will be: (1) being currently receiving psychological treatment, (2) having a history of Eating Disorder or Personality Disorder, (3) presenting a medical illness or physical disability that prevents participation in the research, and (4) being pregnant.

Recruitment and randomization

Participants will be recruited through e-mail, social networks (i.e., Facebook and Instagram), and word of mouth. Furthermore, posters will be placed in the University of Valencia. Women interested in the study will be directed to our lab, and will receive further information about the study and what participation entails, as well as the hyperlink to the screening. The screening will be carried out using the LimeSurvey web platform. Demographic data (i.e. gender, age, education level, and nationality) will be collected. The Eating Attitudes Test-26 (Garner, Olmsted, Bohr & Garfinkel, 1982), Multidimensional Assessment of Interoceptive Awareness (Mehling, Daubenmier, Acree, Bartmess & Stewart, 2012), Body Shape Questionnaire (Cooper, Tylor, Cooper & Fairburn, 1987) and Multidimensional Body Self Relations Questionnaire (Cash, 1990) questionnaires will be administered. Those one who are eligible to participate will be invited to the laboratory, where they sign a written informed consent form and are randomly assigned to one of the two conditions (experimental vs. control). In each one, the order of presentation of the perspectives (egocentric vs allocentric) will be counterbalanced as well. The allocation of the participants in each group and the order of presentation of the perspectives will be generated through a randomization website (https://www.random.org/). Participants will agree to participate before the random allocation and without knowing to which condition they will be assigned. However, for practical reasons, researchers will not be blind to the assigned condition.

Participants will be free at any time to withdraw from the study without giving any explanation.

Measures

Women will be assessed at baseline, pre-intervention, and post-intervention. Assessments will be conducted via a commercial online survey system (www.limesurvey.org) or via other procedures at laboratory.

Socio-demographic variables.

The following socio-demographic data will be collected: gender, age, education level, and nationality. In order to contact them, participants will be asked to provide an email address or a phone number.

Embodiment questionnaires.

The embodiment questionnaires evaluate the efficacy of the procedure to induce a sensation of ownership of the virtual body. At the end of each virtual immersion it was administered an adapted version of the embodiment questionnaire developed by Longo et al. (2008), which has 10-item self-reported and it is answered using a 7-point Likert response scale. At the end of the procedure, participants will answer an adapted version of the embodiment questionnaire developed by Piryankova et al. (2014)., which has 16-item self-reported in a 7-point Likert response scale. Both questionnaires evaluate the three embodiment components: ownership (e.g., 'I feel as if the virtual body is my body'), location (e.g., 'I feel as if I am inside the virtual body') and agency (e.g., 'I feel I have the control over the virtual body').

Eating Attitudes Test-26 (EAT-26) (Garner et al. 1982).

It is an abbreviated 26-items version of the EAT-40 created by Garner et al. (1982). It is a self-reported questionnaire with 26-items on a 6-point Likert response scale, grouped in three subscales: Dieting, Bulimia and food preoccupation, and Oral Control. It measures symptoms and concerns characteristic of eating disorders. The 26-item version is highly reliable and valid. Originally it was developed to diagnose AN, but actually it has been used as a screening tool to assess eating disorder risk even in non-clinical population (Mintz, L.B., 2000).

Multidimensional Assessment of Interoceptive Awareness (MAIA) (Mehling et al., 2012).

It is a self-reported questionnaire with 32-items on a 6-point Likert response scale. It is used to evaluate eight aspects of the interoceptive body awareness: Noticing (awareness of uncomfortable, comfortable, and neutral body sensations), Not-Distracting (tendency not to ignore or distract oneself from sensations of pain or discomfort), Not-Worrying (tendency not to worry or experience emotional distress with sensations of pain or discomfort), Attention Regulation (ability to sustain and control attention to body sensations), Emotional Awareness (awareness of the connection between body sensations and emotional states), Self-Regulation (ability to regulate distress by attention to body sensations), Body Listening (active listening to the body for insight), and Trusting (experience of one's body as safe and trustworthy). The MAIA Spanish adaptation (Valenzuela-Moguillansky & Reyes-Reyes, 2015), shown appropriate indicators of validity and reliability, with Cronbach alpha coefficient of 0.90 for the total scale, and values between 0.40 and 0.86 for the different subscales.

Body Shape Questionnaire (BSQ) (Cooper et al., 1987).

It consists of 34-items on a 6-point Likert response scale, and is used to assess the attitudes of satisfaction or dissatisfaction with the figure, and the corporal concern. It serves to discriminate

people without problems vs. people concerned about their BMI vs. people with an eating disorder. It shows a good internal consistency (0.97), reliability test-retest (0.88), and concurrent validity with other body satisfaction assessments (Cooper et al., 1987). The BSQ-40 Spanish validated version (Raich et al., 1996) will be used in this study.

Multidimensional Body Self Relations Questionnaire (MBRSQ) (Cash, 1990).

It is used to evaluate the attitudinal aspects regarding the body image construct. It is a self-reported questionnaire with 69-items on a 5-point Likert response scale. The original version was characterized by 7 factors, while Spanish validation will be used in this study (Botella, Ribas & Ruiz, 2009). It presents 45-items grouped in 4 factors (Subjective importance of corporality; Behaviors oriented to maintain the physical form; Physical attractiveness self-assessed; Care of physical appearance). The internal consistency in the Spanish version is high (0.884).

State Self-Esteem Scale (SSES) (Heatherton & Polivi, 1991).

It is used to measuring change in self-esteem. In this case, SSES will be performed to observe changes in the self-esteem during the experiment. SSES consists in 20-items on a 5-point Likert response scale, grouped in 3 factors: Performance, Social, and Appearance self-esteem. It shows a good internal consistency (0.92), a robust factor structure, discriminant and construct validity.

Real Body Size Estimation.

Participants will be asked to estimate the width of their shoulders, waist and hips, by asking the participants to paint a cross on a blackboard, indicating the distance between the right and left side of that body parts (e.g., 'the distance between the right and left shoulder'.) The order of the body parts will be counterbalanced. Participants will be also invited to estimate their weight and height.

Virtual Reality Body Size Estimation.

A female standard virtual body has been developed for all participants -to see it in a first person point-of-view or in a third person point-of-view in a mirror. The participant will not be able to see the face or the hair of the avatar. It will be possible to choose the body size along a continuum from 133 cm of waist and 151 cm of hips (extremely overweight) to 65 cm of waist and 88 cm of hips (thin), covering a BMIs rate from 42.5 to 12.5. The avatar is presented with a BMI similar to participant's one (maximum 0.5 points of difference), then it is increased and decreased 2 point BMI as an example and the participant is asked to modify the avatar until consider that the avatar's abdomen coincided with their real abdomen.

Actual Body Measures.

The actual body dimensions and the height will be measured by the experimenter, and the weight will be measured using the TANITA,

a body composition analyser (model: BC-420 MA) which can be used in the screening of certain adult diseases and conditions related to body weight and composition.

Stimulus generation and technical setup

Thirty-one female avatars have been developed, using the 3D modelling program "MakeHuman". This program allows to create 3D human figures, considering parameters such as age, percentage of muscle mass, percentage of fat mass, total weight, height of the avatar and the proportions between different body parts.

Thirty-one female figures have been designed, with a height of 1.65 cm and approximately 25 years of age. The avatars' size will increase linearly their BMI from 12.5 to 42.5 (images a and b, Figure 1), with values of change between avatar located from 0.95 to 1.05 units of IMC. These changes will be obtained varying the total weight and keeping the proportions between the different parts of the body stable, adjusting to how they vary in real human bodies to obtain realistic bodies.

The altered dimensions between each avatar refer to volume of the glutes, thighs, abdominal muscles, hips, waist, chest, fingers, arms, and face (Figure 2). The "smooth" option can be selected to obtain a real effect of the skin, using the Catmull-Clark methodology, which also includes eyes, eyebrows, eyelashes, hair and other details as nails. The avatars are Caucasian, and wear jeans and a short-sleeved T-shirt, with blue shoes.

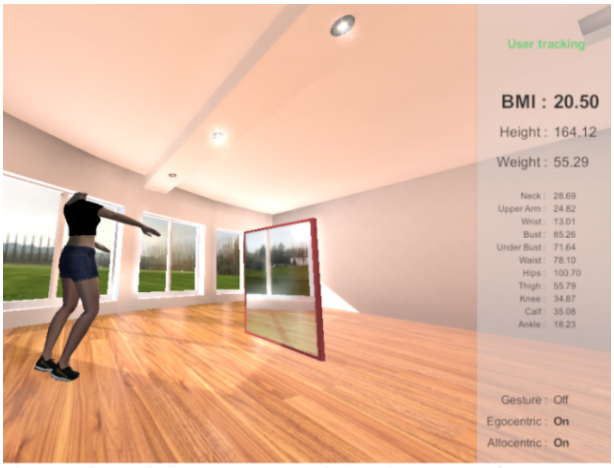

Figure 2: Screen capture of how the program will be viewed from the experimendor's point of view. To the right of the image we can see each one of the parts of the body with its measurements.

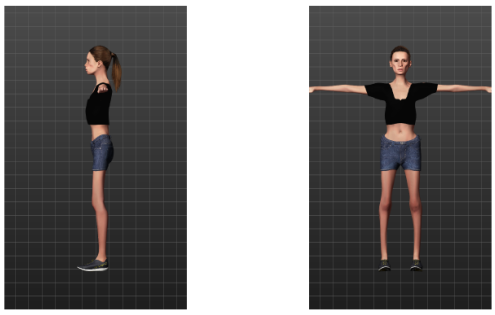

Image a (BMI=12.5)

Image b (BMI=42.5)

Figure 1: Example of the avatars.

Procedure

Once in the laboratory, participants will fill out the SSES and will perform a "real" body size estimation of the width of several parts of their body as we have explained before. Then, participants' weight and height will be measured.

Afterwards, participants will be asked to put on the virtual helmet (Oculus Rift) to perform the task from an egocentric or allocentric perspective (1st vs. 3rd point-of-view), in a counterbalanced manner. During the egocentric perspective, participants will have to look down to see their virtual avatar, while in the allocentric perspective the avatar will be reflected in a mirror facing them.

In order to facilitate the feel of embodiment with the avatar, participants will be asked to observe the virtual environment, a room with white walls and wooden floor, and to observe their virtual body, which will have the same BMI that them. They will be asked also to move slowly for one minute (in order: move left hand, right hand, left leg, and right leg). Then, they will have to choose the size of the virtual body that they think could match with their real body size, after to have increase and decrease of 1-2 points BMI as an example. Then, participants will be asked to answer to the SESS and Longo's embodiment questionnaire. Once they take off the Oculus Rift, participants will be asked to play Tetris during two minutes as a distraction task (Holmes, 2009).

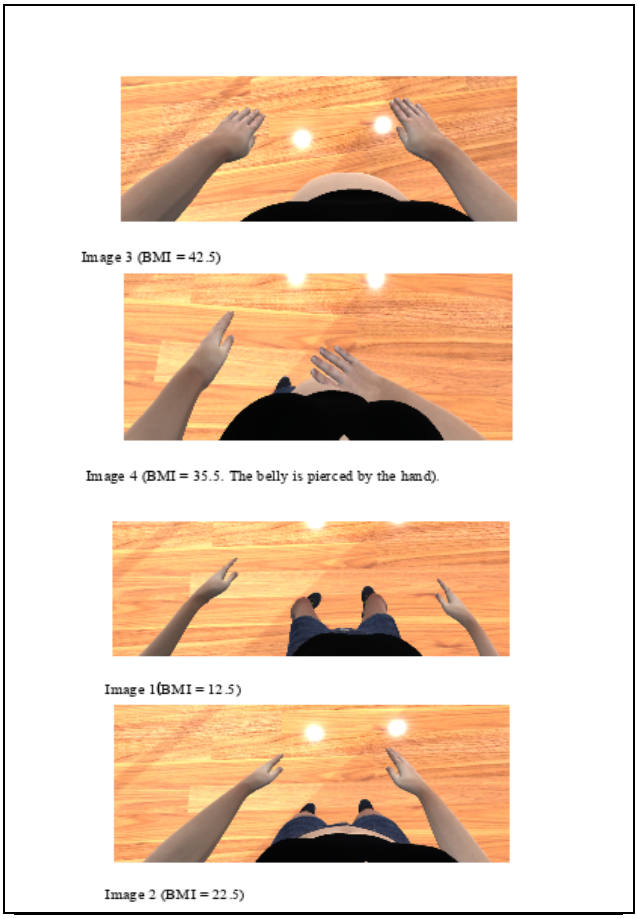

Figure 3: Experimental task. Pictures show the thinnest avatar (BMI = 12.5, image 1), the biggest avatar (BMI = 42.5, image 3) and the middle one (BMI = 22.5) in an egocentric perspective. The image 4 shows how the belly is pierced by the hand in the experimental task in the egocentric perspective.

Afterwards, participants will be asked to wear another time the virtual helmet. This time they could see an avatar with 2 points BMI more than the body size chosen by them before, but they will be informed that it actually is the size they chose. Participants will be asked again to observe the virtual environment, to observe their virtual body. They will be asked also to move slowly for one minute (in order: move left hand, right hand, left leg, and right leg). Then, they will

have to perform a task during a minute and a half, depending by the condition (control vs. experimental). The control condition task consisted in continuous moving slowly in the order given before. The experimental condition task consisted in touch their real abdomen- first with one hand and then with the other- while they were looking at their abdomen (Figure 3).

Thereafter, participants will answer the Longo's embodiment questionnaire and the SESS. Once they take off the virtual helmed, participants will perform another time the "real" body size estimation task.

Then, participants will be asked to wear the Oculus Rift. They will observe again the virtual environment, and their virtual body, which will have the same BMI that them, and to move slowly for a one minute (in order: move left hand, right hand, left leg and right leg). Then, they will be asked to select the size of the virtual body that they think could match with their real body size, after to have increase and decrease of 1-2 points BMI as an example, and they will answer the Longo's embodiment questionnaire, the SESS and the Piryankova's adapted embodiment questionnaire.

Once they take off the Oculus Rift, participants will be playing Tetris during ten minutes as a distraction task (Holmes, 2009), and the they will perform all the procedure from the other perspective (egocentric or allocentric).

Lastly, the real body width of their shoulders, waist and hips will be measured.

Data analysis

All analysis will be conducted using IBM SPSS statistics for Windows, version 24. First, relevant statistical analyses will be performed to verify proper randomization (i.e., independent sample t test for equivalence of the groups). Descriptive statistics for the variables included in the study will be carried out. Furthermore, a series of repeated-measures mixed ANOVAs with planned contrast (2X2X2) will be performed, taking into consideration one intergroup variables (i.e., condition: experimental vs control) x two intragroup variables (i.e., perspective: egocentric vs allocentric, and assessment time: pre vs. post) for each dependent variable. Effect sizes in the improvement of the body size estimation tasks will be also estimated. The analytic methodology will be reviewed before analyzing the data, in order to select the most appropriate analytic procedure.

Discussion

A negative body size experience has been theorized as a common antecedent in AN, but it is also present in several psychological problems, impacting on the people's well-being, and therefore in their quality of life. This paper presents the study protocol of this novel multisensorial VR paradigm to assess and treat BID.

The protocol presents several strengths. First, it is based on VR, which has been proven to be particularly effective in the assessment and treatment of BID. Second, a wide range of avatars - with subtle differences between them – will be

available, so participants will be able to easily find the one that fits with the mental representation of their body image. Furthermore, the avatars will be validated before their use. And third, the protocol allows the study of the differential impact of the manipulation of the body image from the two reference frames (egocentric or allocentric perspectives).

This study also presents some limitations. First, screening will be conducted online. Some evidence suggests that psychometric proprieties can change when the assessment is performed on the web (Buchanan, Johnson & Goldberg, 2005). Second, the proposed avatars present some limitations: (1) they will be developed based on standard measures, without taking into account the real body of each participant, and (2) they will be Caucasian, being able to hinder the identification with the avatar in other ethnic groups.

In summary, we have developed a protocol to assess and treat BID. This protocol is intended to be an effective tool that allows the development of a more realistic corporal representation adjusted to the own body size. If shown to be effective, a future step would be to propose this procedure as a tool to use during therapies addressed to people who experience body dissatisfaction and alteration of the body schema, due to the impact it has in their quality of life.

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Availability of data and material

It is not possible to share data because the study is in progress. We are now at the stage of avatars generation.

Competing interests

The authors declare that they have no competing interests.

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