

**Evaluation de l'image du corps chez l'adolescente souffrant d'anorexie  
mentale**

**T H È S E A R T I C L E**

**Présentée et publiquement soutenue devant**

**LA FACULTÉ DE MÉDECINE DE MARSEILLE**

**Le 31 Octobre 2018**

**Par Monsieur Sheldon FISHER**

**Né le 12 août 1990 à Marseille 08eme (13)**

**Pour obtenir le grade de Docteur en Médecine**

**D.E.S. de PSYCHIATRIE**

**Membres du Jury de la Thèse :**

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**Monsieur le Professeur NAUDIN Jean**

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## **Abréviations**

AN	Anorexia Nervosa
BED	Binge Eating Disorder
BID	Body Image Disorder
BPI	Body Perception Indice
BIVRS	Body Image Virtual Reality Scale
BMI	Body Mass Index
DSM-V	Diagnostic and Statistical Manual of Mental Disorders 5th Edition
ED	Eating Disorders
FRS	Figure Rating Scale
FTP	Fixation Time Percentage
VR	Virtual Reality

## **Introduction**

The lifelong prevalence of anorexia nervosa (AN) in adolescents and young adults is estimated at 0.3 to 0.9 % (1,2) . Due to its major somatic complications associated with malnutrition and purging habits, and a high suicide rate, anorexia nervosa remains the most fatal psychiatric disorder with a mortality rate of 1 % per year of disease evolution in clinical populations (1) . Furthermore, it is important to note that relapse rates are as high as 40% during the first 12 months following complete discharge from specialized care (3). For these reasons, multidisciplinary management of AN is complex and represents a public health challenge. One of the most challenging aspects of managing AN is Body Image Disorder (BID) according Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (4), which remains poorly understood and seems to be multifactorial. Different authors seem to agree on its definition of being the association of distorted sensorial perception “body perception disorder” and affective cognitive perturbation “body dissatisfaction” (5,6). BID, which can be found in most Eating Disorders (ED) , is a key determinant of disease evolution, as more severe forms are associated with higher relapse rates and stronger desire for weight loss (5,7) . In fact, BID contributes to about 35% of the total risk for AN relapse (8) . Therefore, treating BID plays a primordial role in managing these patients. However, to evaluate treatment response and its effectiveness, assessment of the symptoms of BID, and its variation throughout the treatment period is crucial. Assessment tools are numerous, but the grand majority are somewhat old. The following tools are mentioned from the least to the most recent: paper marking (9), measuring by caliper (10), use of figure rating scales (FRS) (11–15) and deforming mirrors (16). Methods of deforming the body wholly or partially using photographs or videos have also been described by some authors (17–19). These different methods can be grouped into “whole body methods” or “depictive methods”, and “body part methods” or “metrics methods”. They can be also classified according to two axes, one ranging from perceptive to affective-cognitive, while the

latter from implicit to explicit (20,21). Also, questionnaires specific for BID are frequently used, such as the Body Shape Questionnaire (BSQ) (22), the Body Image Avoidance Questionnaire (BIAQ) (23), the “Drive for thinness” and “body dissatisfaction” scales of the Eating Disorder Inventory-2 (EDI-2) (24), the Body Attitude Test (BAT) (25), Body Esteem Scale (BES) (26), and the Body Image Questionnaire (BIQ) (27). Till today, literature data are heterogenous and inconclusive concerning the evaluation of BID, which reflects the heterogeneity of assessment tools used. Recent technological advancements such as Virtual Reality (VR) have added new dimensions to our assessment capabilities. VR seems as a promising tool for enhancing BID evaluation as it proposes immersing patients in an environment of self-perception similar to what they feel daily in the real life. Indeed, this technology allows the individual to interact live and intuitively with an artificially created environment, using one’s own senses and competences (28). Live interaction with the 3D environment gives the impression of existing in that environment and hence reinforces total immersion (29). Therefore, we can presume that this perceptive immersion would allow for a more accurate evaluation of BID, and for more effective BID psychotherapy. The first studies reporting the use of VR for BID in AN, relate primarily to therapy by body exposure in virtually created environments. The studies of Riva et al on Experiential Cognitive Therapy (ECT) in 1999 (30), of Conxa Perpiñá et al (31,32), and of Gutierrez-Maldonado et al (33), show better improvement rates of BID in patients undergoing VR based-therapy compared to controls. More recently, a Danish study showed that using “Full Body Illusion” coupled with VR resulted in BID improvements in adult patients with AN (34). While VR seems to be an effective therapeutic tool in ED, its use in evaluating BID has not been widely studied. Firstly appears the Body Image Virtual Reality Scale (BIVRS) developed by G. Riva et al in 1998 (35), which consists of seven and later nine, 3D male and female figures ranging from underweight to overweight. Participants are asked to select figures that correspond firstly to their perceived body form followed by their desired form. The

immersive application of VR developed by C. Perpina et al in 1999 (31) proposes a 3D modeled human figure with body parts that can be modified by the participant. None of these two previously described VR applications, to the best of our knowledge, have undergone validation studies or have been compared to standard reference tools. Finally, in 2018 and in parallel to the expansion of VR to psychotherapy for ED (36), Mölbert SC et al opted for using modeled avatars of female adults with AN in order to shed light on key elements and mechanisms of BID. The objective was to ask participants to modify the morphology of either their own modeled avatar or a standardized similar model, to reach a final model similar to that of their perceived actual form followed by another of their desired form (37). This study showed that there were no differences between using personalized 3D models or standardized ones. Furthermore, the authors found that female adults with AN were equally able to correctly estimate their perceived forms using both personalized and standardized avatar models, as did their healthy counterparts. However, participants with AN showed a thinner desired body than the control group. Hence, the authors argue for an affective-cognitive perturbation rather than a distorted visual perception as the root cause of BID. If personalized 3D models that are rendered very realistic, modify AN patient's own corporal evaluation, it seems legit to wonder if this evaluation varies when standardized 3D avatars are used instead of the more commonly used paper-based FRS, as 3D models are visually more realistic than 2D figures (11–13). In fact, to the best of our knowledge, no study has compared the use of VR through non-modeled 3D avatars, to the paper-based FRS, for BID evaluation in adolescents with AN. Nor has the latter been studied in correlation to classic BID psychometric tests in adolescents with AN. Therefore, this retrospective and comparative study tests the hypothesis that the immersive conditions created by VR, and the enhanced visual perceptions offered by 3D avatars would modify body image evaluation by adolescents with AN, compared to the paper-based FRS. Findings from this study will help us better define the use of this new tool for the first time in

adolescents with AN, in comparison to the classical paper-based FRS which is still widely used clinically (35).



## Methods

### Subjects

Evaluation data of 31 female adolescents with AN aged between 11 and 18 years, that were managed as inpatients or outpatients in the Salvator University Hospital in Marseille (France) from November 2017 to April 2018, were retrospectively studied.

### Procedures

The diagnosis of AN was established by a child and adolescent psychiatrist specialized in EDs, according to the 5<sup>th</sup> edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria. All data regarding symptomatic evaluation of patients, whether obtained by questionnaires, paper-based FRS, or avatar-based VR rating scale, are commonly required information that is used in the routine management of our patients, who are systematically informed beforehand that anonymized data could be used for research purposes.

Before any intervention or therapy, and outside mealtimes, participants with AN were asked to evaluate their perceived and desired body figures using the paper-based FRS (14), followed by a VR-based avatar rating scale (C2CARE PSY software). The same questions were asked in both evaluations: 1) “Which of these figures corresponds best to you at this moment?” 2) “Which of these figures do you wish to have the most?” The Body Mass Index (BMI) of each figure in both the paper and VR evaluations are noted in the patients’ medical files. A Body Perception Index (BPI) is then calculated by dividing figure-based perceived BMI, by the patients actual BMI, multiplied by 100 (10), and a body dissatisfaction score corresponds to the difference between perceived BMI and desired BMI (38). BPI is expressed as a percentage of actual BMI and indicates overestimation or underestimation when its above or below 100, respectively.

The paper-based FRS consists of 10 female body figures drawn in black and white, ranging from 1 to 10 according to an increasing BMI from 15.65 to 27.01 kg/m<sup>2</sup> (14). The VR software used in our unit is C2CARE PSY developed by C2CARE (Toulon, France) under the UNITY 3D framework. This software was run on our Windows 10 based MSI Gamer laptop. The (Oculus Rift) headset was used for VR exploration. The C2CARE software has a dedicated platform (C2Nutri) which creates ten 3D female avatars arranged in a circle with an angle of 36 degrees between each avatar. Thus, the participant can observe in a circle spanning 360 degrees 10 avatars numbered from 1 to 10 based on an increasing BMI from 10 to 30 kg/m<sup>2</sup> which are masked from the patient but not the observer. A head tracking software calculates the time patients spend looking at each avatar, which enables the calculation of the Fixation Time Percentage (FTP). FTP corresponds to the total time spent looking at any one avatar divided by the overall time spent looking at all 10 avatars, multiplied by 100. This allows for the implicit measurement of explicit choices of patients. BMIs of avatars, with whom the participants engage the most and least, are also noted, alongside their average. The VR experience lasts for a total of 15 minutes which is divided into 2.5 minutes of initial free exploration of all avatars, followed by asking the first question for which the participant has 5 minutes to choose the avatar that corresponds the most to her perceived figure. The second question is later asked, for which 5 minutes are given to choose the avatar corresponding to the the desired form, and finally the VR experience ends with 2.5 minutes of free exploration.

Self-administered questionnaires are filled out by patients during their visit for establishing baseline symptoms and proposing adapted healthcare plans. These questionnaires relate to symptoms of eating habits (EDI-2) (24), relationship to own body (BSQ-french version) (22), depressive symptoms (Children's Depression Inventory CDI) (39), and anxiety symptoms (State Trait Anxiety Inventory STAI-Y) (40).

## Statistical Analysis

Parametric variables are represented as mean  $\pm$  standard deviation (SD). Statistical analysis was performed using the SPSS 16.0 software. Pearson's coefficient was used to assess correlation between measures of perceived and desired body form, BPI, body dissatisfaction based on both paper and VR FRS, in relation to questionnaire-derived scores of depression, anxiety, drive for thinness, body dissatisfaction and BID. Correlation between the aforementioned and BMI, age and disease duration were also studied. Student's T-test was later used to compare paired data of perceived and desired body forms, BPI and body dissatisfaction in VR with results of the paper-based FRS. One-way ANOVA was used to study differences in FTP based on avatars using a Greenhouse-Geisser test derived intra-subject factor. When differences were significant, Student's T-test was used to study paired data.

## **Results**

Patients with AN (n=31) had a mean age of 13.9 years ( $\pm 4.25$ ) and a mean BMI of 16.6 ( $\pm 2.1$ ) kg/m<sup>2</sup> with a mean disease duration of 22.8 ( $\pm 13.45$ ) months. Twenty-two had a restrictive form of AN while 9 had a purging type. Psychometric evaluation revealed a mean score for depression and anxiety of 17.2 ( $\pm 8.9$ ) and 48.1 ( $\pm 15.1$ ), respectively. Mean VR-based BPI was found to be 116.01 ( $\pm 19.89$ ) and was not found to be significantly correlated with scores of depression nor anxiety. However, a positive correlation was found with more specific scores of EDs such as the drive for thinness dimension from the EDI-2 ( $r = 0.5$ ,  $p = 0.008$ ) (Figure 1), body dissatisfaction ( $r = 0.43$  ;  $p = 0.02$ ), interpersonal distrust (  $0.47$  ;  $p = 0.014$ ), social insecurity ( $r = 0.39$  ;  $p = 0.04$ ), and with the sub-score of avoidance/social shame of the BSQ ( $r = 0.41$  ;  $p = 0.03$ ).

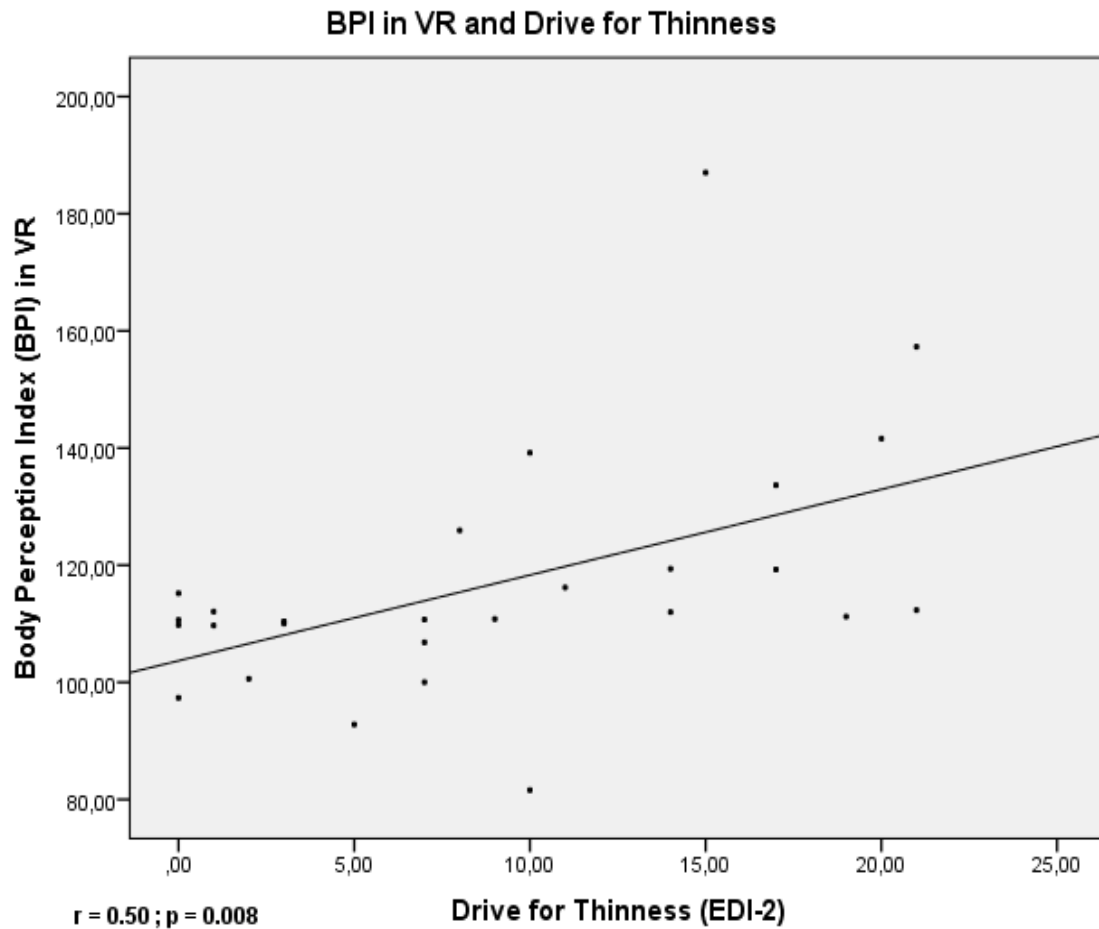


Fig 1: Positive correlation between the Body Perception Index score in Virtual Reality and the Drive for Thinness score at EDI-2

Average VR-based body dissatisfaction score was  $1.5 (\pm 4.7)$  and was positively correlated with the total score of depression ( $r = 0.39$ ;  $p = 0.036$ ), and the sub-score of low self-esteem of the CDI ( $r = 0.37$ ;  $p = 0.049$ ). Moreover, positive correlations were also found with more specific scores of ED such as the drive for thinness of EID-2 ( $r = 0.59$  ;  $p = 0.001$ ), body dissatisfaction ( $r = 0.47$ ;  $p = 0.013$ ) (Figure 2), social insecurity ( $r = 0.44$  ;  $p = 0.023$ ), interpersonal distrust ( $r = 0.42$  ;  $p = 0.028$ ), ascetism ( $r = 0.60$  ;  $p = 0.001$ ), impulse control ( $r = 0.66$  ;  $p < 0.001$ ), total BSQ score ( $r = 0.5$  ;  $p = 0.008$ ), and sub-scores of body dissatisfaction in BSQ ( $r = 0.41$ ,  $p = 0.035$ ) (Figure 3), avoidance/social shame ( $r = 0.55$  ;  $p = 0.003$ ) and use of laxatives ( $r = 0.54$  ;  $p = 0.003$ ).

### BD in VR and Body dissatisfaction in EDI-2

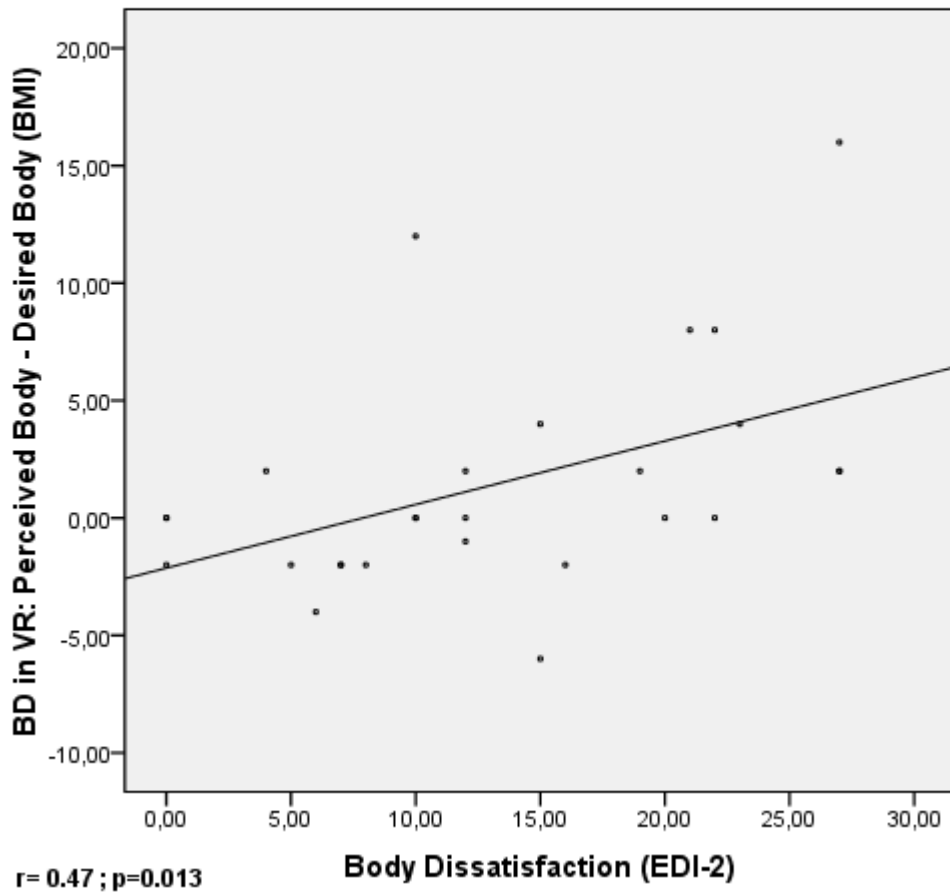


Fig 2: Positive correlation between the Body Dissatisfaction score in Virtual Reality and the Body Dissatisfaction score in EDI-2

### BD in VR and Body dissatisfaction in BSQ

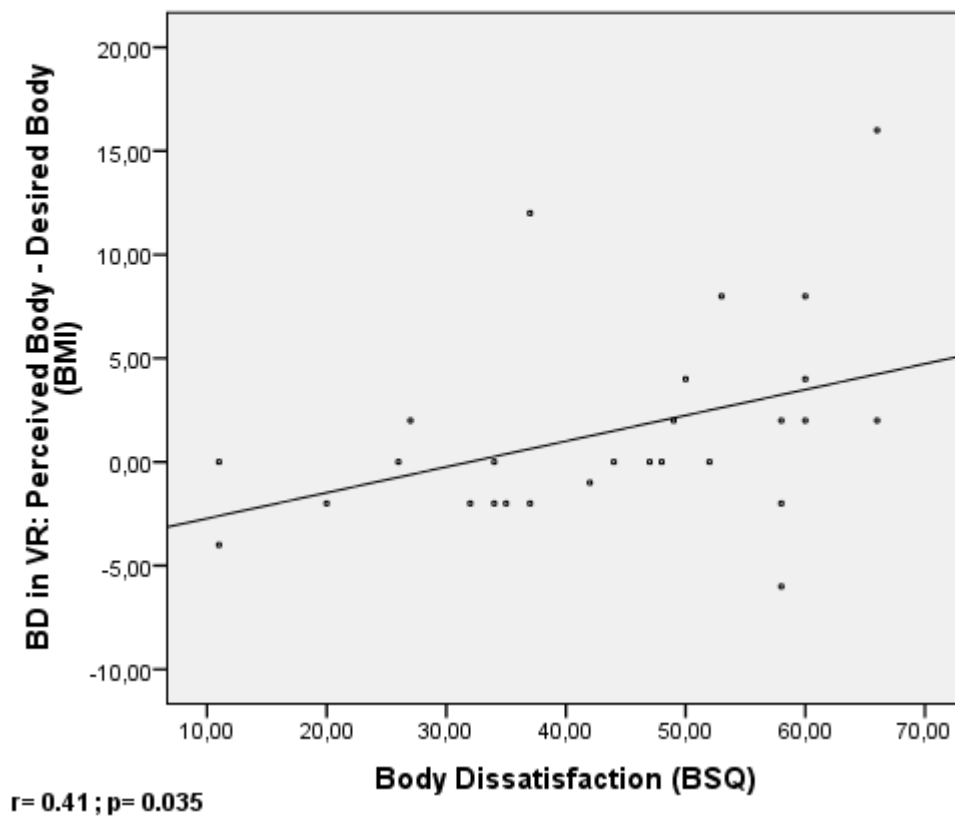


Fig 3: Positive correlation between the Body Dissatisfaction score in Virtual Reality and the Body Dissatisfaction score in BSQ

Similarly, statistically significant positive correlations were found between scores of BPI, body dissatisfaction based on both paper-based FRS, and different questionnaires.

As for comparing the two evaluation methods, VR and paper-based FRS, no statistically significant difference was found between average scores of BPI, body dissatisfaction, BMI of perceived and desired figures (Table 1)

Table 1 : Body image disorder evaluation based on paper-based FRS and VR-based figure rating.

Body Image <sup>a</sup>	Paper FRS N = 31	VR figure rating N = 31	P value
Perceived figure BMI (kg/m <sup>2</sup> )	19.75 ± 3.04	19.25 ± 3.54	0.26
Body Perception Index (BPI = (perceived BMI /real BMI) *100) (kg/m <sup>2</sup> )	119.63 ± 20.57	116.01 ± 19.89	0.152
Desired figure BMI (kg/m <sup>2</sup> )	17.94 ± 1.16	17.81 ± 2.7	0.723
Body dissatisfaction score (perceived BMI-desired BMI)	1.7 ± 3.7	1.5 ± 4.7	0.636

<sup>a</sup> Data is represented as average ± standard deviation



With regards to head tracking, one-way intra-subject ANOVA and later T-tests of avatars compared two by two, showed that FTP differed significantly according to avatars in VR ( $F(3.8, 111.6) = 9.25$  ;  $p < 0.001$ ), and that significant differences were principally found between avatars 4,5,10 and the rest (Figure 4).

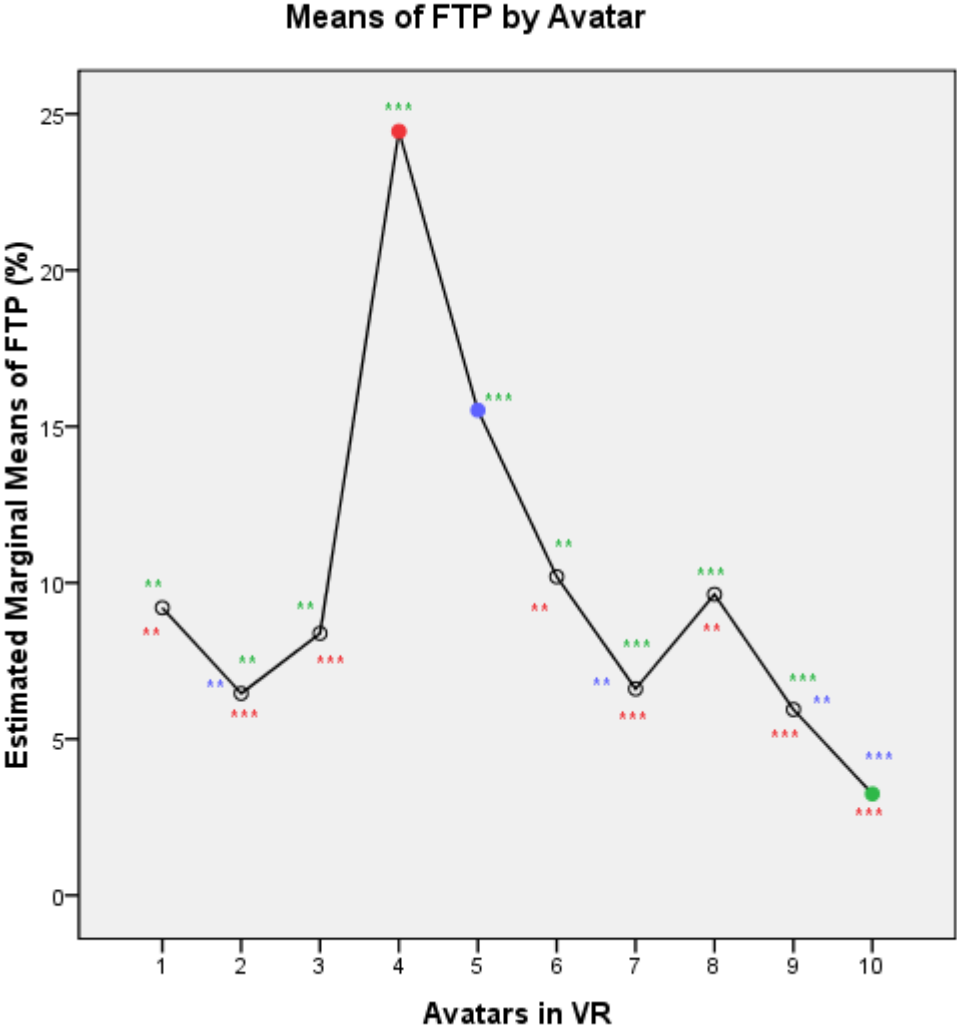


Fig 4: Means of FTP by Avatar and Significant Differences (\*\*\*)  $p < 0.001$  ; \*\*  $p < 0.01$ )

We can also note that the average BMI of the mostly engaged avatar ( $17.93 \pm 3.8$  kg/m<sup>2</sup>) is not significantly different than that of the desired figure in VR ( $p = 0.739$ ). Furthermore, it was correlated only with patients' real BMI ( $r = 0.65$  ;  $p < 0.001$ ). Average BMI of the least engaged avatar was  $24.9 (\pm 7.7)$  kg/m<sup>2</sup>.

Finally, no statistically significant correlation was found between VR-based scores of BP, body dissatisfaction, desired BMI, and other parameters such as real BMI, age or disease duration. Only VR-based perceived BMI was significantly correlated with patient's real BMI ( $r = 0.5$ ;  $p = 0.002$ )

## **Discussion**

To our knowledge, this is the first study in the literature that compares BID evaluation by VR-based 3D standardized avatars, to that performed by the classic paper-based FRS which remains widely used clinically (11–13), in addition to classic psychometric tests of BID and more precisely body dissatisfaction in adolescents with AN.

Firstly, it must be noted that there was a moderate tendency in patients with AN to overestimate own body size regardless of the assessment tool used; paper based FRS or VR. This observation is concordant with findings from other authors (10,14,17,41–43), even though few studies have found a under-estimation (37,44), or that estimation was variable based on whole body or body part estimation (45), in addition to contradictory data in children and adolescents (46).

Moreover, the higher the BID scores measured by VR-based BPI and body dissatisfaction, the higher were the relating scores of EDI-2 and BSQ concerning this dimension (drive for thinness and body dissatisfaction of EDI-2, body dissatisfaction and total score of BSQ). However, as noted by other authors we find that the cognitive-behavioral component of BID, evaluated by the body dissatisfaction score (38) in VR, is better correlated with psychometric scales than the perceptive component BPI. This is not surprising as these psychometric scales and questionnaires are known to evaluate affective and cognitive dimensions better than neurosensorial and perceptive ones (38).

Our results show concordance between results obtained by VR and those obtained by psychometric tests validated for evaluating BID in adolescents with AN. It must be precised that paper-based FRS evaluations of BID are equally correlated with validated psychomotor tests. Our results, however, contradict the findings of others (37), who found in a population of 24 women with AN, that body dissatisfaction assessed by VR biometric avatars was low, but when assessed by questionnaires was found to be high. Nonetheless, and as suggested by the

author, it is probable that biometric avatars allowed a high-quality perceptive evaluation of body form, while questionnaires reflected the cognitive-behavioral errors that would be the only perturbed aspect of AN. Following on the same thought, comparing our results to those of Mölbert et al's study would suggest that BID evaluation by our VR software tends more toward showing an altered cognitive-behavioral component in our patients than the perceptive component of the disorder.

As for psychometric evaluations and VR, interestingly it is the VR-based body dissatisfaction score and not the VR-based BPI that was higher whenever patients scored high for depression and low self-esteem. This confirms literature data relating depression to significantly higher body dissatisfaction. Indeed K. Jackson et al found in a multi-ethnic cohort of 405 American women aged from 42 to 52 years, that more depressive symptoms were associated with more important body dissatisfaction (47). Likewise, the study of June et al in 2016 showed that in 242 female adults with AN treated by outpatient psychotherapy, depression paralleled body dissatisfaction throughout the entire treatment period (48). Their study also showed a correlation between anxiety and body dissatisfaction, which was not found in our results. Finally, concerning the relationship between self-esteem and body dissatisfaction, our results are concordant with the study of Brechan et al in 2015 (49), which showed that body dissatisfaction negatively impacted self-esteem and combined with depression triggered restrictive ED, binge eating disorders and compensatory behaviors in 320 Norwegian students of both sexes.

The perceptive component of BID was not found to be correlated in our study with anxiety-depressive elements nor to self-esteem. This finding partially contradicts that of Panns N et al in 2015 who showed that more severe depressive symptoms were associated with perceptions of having fatter bodies in 1449 non-depressed, in remission and depressed adults of both sexes

(50). However, it is important to highlight that in the previous study, depression in all forms was correlated with body dissatisfaction, although only severe depression was associated with body perception disorder.

Furthermore, the two scores (BPI and body dissatisfaction) and desired BMI by VR, were not significantly correlated to real BMI, age, nor disease duration. This is discordant with what Panns et al found, that body dissatisfaction increased with higher BMIs in participants without AN (50). Our study finds that perceived BMI in VR increased proportionally with higher real BMI in female adolescents with AN. This confirms findings in depressed patients (50), in adults suffering from anorexia and/or bulimia (51), and in adults with restrictive and purging AN that share the common finding of a perceived BMI that increases with real BMI, as well as overestimation of own BMI that increases as well with higher real BMI (52) (53).

Calculating of FTP of different avatars using the head tracking technology shows that the two avatars the most widely engaged, represent the malnutrition and underweight states according to WHO criteria. On the contrary, the least engaged avatar corresponds to a state of obesity. These results confirm the findings of Pinhas et al in 2014 that showed adolescents with AN made more eye contact with thin figures than fat ones during visual explorations of images (54). To explain this finding one can share the idea developed by Pinhas' team, which believes that adolescents with AN prefer eye contact with images of thin figures in order to increase their motivation to obtain a similar result. Furthermore, we can explain our results by the phenomena of addiction to thin figures (55,56), and phobia of fat figures (57) which are described in patients with AN. It is worth mentioning also, that the average BMI of the most engaged avatar which would be considered the most attractive (54), did not differ significantly from that of the avatar chosen as "desired" by the participant. This leads to think that the explicit declaration of the patient is reliable concerning the desired avatar. We can note as well that the lower the patients

BMI, the lower the BMI of the avatar the most engaged visually. This points towards an addiction to the thin body that increases with malnutrition, and that could be in line with pathophysiological explanations of addiction to thin body reinforced by food restriction (55).

Finally, the comparison between the two evaluation tools, paper and VR based figure ratings, did not reveal statistically significant differences. Therefore, BID evaluation using VR-based standardized 3D avatars seems concordant with what we use classically in paper-based FRS. This finding might be explained by the fact that these two assessment tools allow for an evaluation that is essentially based on cognitive-behavioral and explicit dimensions of BID. Hence, the higher visual quality of the avatar provided by VR compared to paper does not seem to lead to better evaluation of perceptive distortions, which is concordant with the need to utilize biometric modeled avatars to allow better perception of the patients of their own bodies. Furthermore, the immersive sensation provided by VR that seems capable of providing the best conditions for self-evaluation, do not seem to modify adolescent AN patients' body evaluation compared to figures on paper. This result is in agreement with Mölbert's finding that no significant difference is shown between evaluation by VR and 2D (37,38). Ameliorating the precision of own body evaluation seems to be achieved through enhanced visual perception provided by biometric tools (37,38) more so than by merely providing conditions of self-immersion, which might even disturb this evaluation (37,58).

This study has some limitations, the first of which relate to the small number of participants and the non-homogeneous nature of the population in terms of sub-types of AN. This limits the ability to generalize findings with certitude as our results need to be confirmed in a larger cohort.

Secondly the absence of a control group due to the retrospective nature of the study is a methodologic limitation which needs to be eliminated by future prospective studies to confirm

findings. However, the absence of a comparative study of the two tools assessed, in addition to the exponential rise in the clinical use of VR in the setting of ED, led us to analyze our data to obtain a preliminary study and share our results that we believe serve as a necessary basis for wide spread utilization of VR in the domain of BID.

Thirdly, the head-tracking technology that we have used is less precise than that of eye-tracking, as head-tracking considers fixation time equivalent to time of head positioning. However, this technology that allows for implicit assessment of patients' intentions and declarations without feeling monitored, seemed very interesting.

Fourthly, results obtained by measures of head-tracking might be possibly impacted by questions asked by the observer. Indeed, when asked to choose the most corresponding and most desired avatars, it is probable that concentration on the required task was paired with increased visual attention and hence more FTP for the chosen two avatars. That said, to minimize this possibility we allowed for 5 minutes of free exploration of avatars, of which 2.5 minutes were given before the first question. Also, equal time was given for both questions. Furthermore, our results show that the most engaged avatars had BMIs closer to desired BMIs than those of perceived ones, even though the first question asks about perceived BMI, which should have led to increased fixation time for avatars of perceived BMI if this bias were to be true.

In conclusion, while acknowledging the aforementioned limitations, we can state that results of BID evaluation performed by VR standardized 3D avatars, are comparable to those obtained by the paper-based FRS. This VR-based evaluation is nonetheless correlated with validated psychometric tests in terms of BID and body dissatisfaction. Finally, the explicit evaluation of body image in VR seems to be partly confirmed by implicit measures of head-tracking. These findings lead to the hypothesis that comparable results obtained by both tools of evaluation

reflect primarily the role of affective-cognitive perturbation in BID. The perceptive component could be better evaluated by using biometric-enhanced assessment tools.

These findings that certainly require confirmation by future studies, seem important for improving our options and choices concerning the most adapted tool for the required dimension of BID to assess. Additionally, these results can help better understand the basis of the BID by VR-based evaluation, in order to later use the therapeutic potential of this promising technology to better treat this disorder in our patients, and more precisely adolescents with AN.



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## SERMENT D'HIPPOCRATE

Au moment d'être admis(e) à exercer la médecine, je promets et je jure d'être fidèle aux lois de l'honneur et de la probité.

Mon premier souci sera de rétablir, de préserver ou de promouvoir la santé dans tous ses éléments, physiques et mentaux, individuels et sociaux.

Je respecterai toutes les personnes, leur autonomie et leur volonté, sans aucune discrimination selon leur état ou leurs convictions. J'interviendrai pour les protéger si elles sont affaiblies, vulnérables ou menacées dans leur intégrité ou leur dignité. Même sous la contrainte, je ne ferai pas usage de mes connaissances contre les lois de l'humanité.

J'informerai les patients des décisions envisagées, de leurs raisons et de leurs conséquences.

Je ne tromperai jamais leur confiance et n'exploiterai pas le pouvoir hérité des circonstances pour forcer les consciences.

Je donnerai mes soins à l'indigent et à quiconque me les demandera. Je ne me laisserai pas influencer par la soif du gain ou la recherche de la gloire.

Admis(e) dans l'intimité des personnes, je tairai les secrets qui me seront confiés. Reçu(e) à l'intérieur des maisons, je respecterai les secrets des foyers et ma conduite ne servira pas à corrompre les mœurs.

Je ferai tout pour soulager les souffrances. Je ne prolongerai pas abusivement les agonies. Je ne provoquerai jamais la mort délibérément.

Je préserverai l'indépendance nécessaire à l'accomplissement de ma mission. Je n'entreprendrai rien qui dépasse mes compétences. Je les entretiendrai et les perfectionnerai pour assurer au mieux les services qui me seront demandés.

J'apporterai mon aide à mes confrères ainsi qu'à leurs familles dans l'adversité.

Que les hommes et mes confrères m'accordent leur estime si je suis fidèle à mes promesses ; que je sois déshonoré(e) et méprisé(e) si j'y manque.



## **Abstract**

### **Objective :**

Assessment of the symptoms of body image disorder (BID) is crucial in anorexia nervosa (AN). Recent technological advancements such as Virtual Reality (VR) have added new dimensions to our assessment capabilities. This retrospective study examines the hypothesis that the immersive conditions created by VR, and the enhanced visual perceptions offered by 3D avatars would modify body image evaluation by adolescents with AN, compared to the paper-based figure rating scales (FRS).

### **Method :**

Data of 31 female adolescents with AN were retrospectively studied. Paired data of perceived and desired body forms obtained by VR and FRS were compared in terms of Body Perception Index (BPI) and body dissatisfaction, and correlation with validated psychometric questionnaires. Head-tracking technology allowed for the implicit measurement of explicit choices of patients.

### **Results :**

Participants with AN overestimated own body size regardless of the assessment tool used. BPI and body dissatisfaction did not differ significantly between FRS and VR. VR-based evaluation was correlated with the psychometric parameters BID and body dissatisfaction. Head tracking revealed significantly longer participant engagement with avatars representing malnutrition and underweight states, while those least engaged corresponded to obesity.

### **Discussion:**

Results of BID evaluation by VR standardized 3D avatars, are comparable to those obtained by paper-based FRS. These findings suggest that comparable results obtained by both tools of evaluation reflect primarily the role of affective-cognitive perturbation in BID. The perceptive component could be better evaluated by using biometric-enhanced assessment tools.

**Keywords :** Anorexia Nervosa, Body Image Evaluation, Virtual Reality, Body Image Disorder, Adolescent.