Virtual characters designed for forensic assessment and rehabilitation of sex offenders: standardized and made-to-measure

Patrice Renaud, PhD, [*†‡], Joanne-L. Rouleau PhD [¶]
Jean Proulx PhD,[¶] Dominique Trottier, PhD cand.,[¶] Mathieu Goyette, PhD cand.[*¶]
John P. Bradford, MD,[§] Paul Fedoroff, MD,[§] Marie-Hélène Dufresne, PhD,[*]
Benoît Dassylva, MD,[*] Gilles Côté, PhD,[*] and Stéphane Bouchard, PhD[†]

[*]Institut Philippe-Pinel de Montréal
[†]Laboratoire de cyberpsychologie, Université du Québec en Outaouais
[‡]Hexagram : Institut de recherche-création en arts et technologies médiatiques
[§]Université d'Ottawa
[¶]Université de Montréal

Abstract

This paper presents two studies pertaining to the use of virtual characters applied in clinical forensic rehabilitation of sex offenders. The first study is about the validation of the perceived age of virtual characters designed to simulate primary and secondary sexual character of typical adult and child individuals. The second study puts to use these virtual characters in comparing a group of sex offenders and a group of non deviant individuals on their sexual arousal responses as recorded in virtual immersion. Finally, two clinical vignettes illustrating the use of made-to-measure virtual characters to more closely fit sexual preferences are presented in Discussion.

Keywords: forensic rehabilitation, virtual characters, virtual reality, immersive technology, sexual plethysmography

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Assessing and rehabilitating criminals are recognized to be one of the most difficult areas of mental health research and practice. And, amongst the diverse psychopathologies that have to be dealt with in clinical forensic practice, criminal paraphilia is undoubtedly one of the most challenging. It is so notably because sex offenders are known to lack motivation to get involve into therapeutic processes and also because they are difficult to assess since sexual deviancies can be highly specific and assessees quite reluctant to disclose their sexual preferences [KB05, RCR$^+$09].

Although there are other means to detect and diagnose criminal paraphilias, penile plethysmography (PPG) is widely used and still accepted as the gold standard in the forensic community [see Experiment 2 for a description; [LG04, ATS97]]. However PPG does not go without problems and important criticisms were raised against it since its inception[KB05, RCR$^+$09, LG04, ATS97, Law03, LM03, MF03]. The latter can be divided into either physiological measurement and stimuli related issues. The present paper addresses the second aspect and proposes possible solutions based on the use of virtual characters to assess and eventually treat deviant and criminal sexual behavior.

It is custom in clinical practice to use audio recordings of deviant sexual scenarios andvisual sexual stimuli (photographs of real naked models) to prompt sexual arousal to be recorded from PPG equipment. Problems arise at two levels with these two methods

though. First, both types of stimulus lack plasticity and vividness and are not faithful enough to the reality of the offenders. Second, as Laws and Gress[LG04] pointed out, the victimization of children is another major shortcoming of assessment procedures that use pictures of real models to arouse either physiologic sexual responses or deviant interest as indexed by PPG[RCR+09].

The rest of this paper presents two studies. The first one is about the validation of the perceived age of virtual characters designed to simulate primary and secondary sexual character of typical adult and child individuals. The second is a PPG study based on these virtual characters conducted with a group of sexual aggressors against children and a group of non deviant individuals with the aim to bring out discriminating sexual preference profiles. Finally, two clinical vignettes illustrating the use of made-to-measure virtual characters to more closely fit sexual preferences are presented in Discussion.

1 Experiment 1

To ascertain the perceived age of a series of virtual characters that we developed, we first conducted a validation study of these stimuli with normal individuals before using them with a group a sexually deviant subjects in a second study based on psychophysiologic assessment of the sexual arousal response using PPG (Experiment 2).

1.1 Participants

126 undergraduate psychology students were recruited to assess the perceived age of a series of virtual characters (107 female, mean age: 22.3 yr old, SD 2.1).

1.2 Materials

The sexual stimuli are 3D virtual characters depicting realistic naked human individuals (see figure1). Five such stimuli are used in the present study. Two adults, a female and a male, both designed to simulate individuals in their twenties, a female child and a male child, both prepubescent and aged between 10 and 12 yrs old, as well as a neutral stimulus, i.e. a textureless virtual character (see figure1). All human-like characters were designed and developed by a team of professional 3D artists to simulate Caucasian mesomorphic body types according to Tanner's developmental criteria to fit the targeted age categories [stage 5 for the adults and stage 1 for the prepubescent children;[Tan73]]. A modeling software whose rational is based on morphism was used. This software allows a progressive shaping of the characters by fusing together their global topologies as well as their local features.

Figure 1: Virtual characters used as sexual stimuli; from left to right, neutral, male adult, female adult, male child and female child (www.behavrsolution.com)

1.3 Procedure

Each character was projected one after the other for a 90 second period on a giant screen installed in a classroom. They were presented in the following order: Female adult, Female child, Male Child, Male adult and Neutral. Subjects had simply to answer the following question in writing for each character: *According to you, how old is the character shown on the screen?*

1.4 Statistical analysis

Data are analyzed following a repeated measures multivariate analysis of variance with Sex as Between-subjects factor and Virtual characters as Within-subjects factor. Sex is used to verify how male and female subjects respectively perceived the age of the characters. Pairwise comparisons are used to compare virtual characters to each other as for their perceived age. An alpha level of .05 was used with all statistical tests.

1.5 Results

Mean and standard deviation of perceived age for each five virtual characters are shown according to participants' sex at table 1. As a first result, we can note

that the Between-subjects factor Sex is not statistically significant (Wilks= .985 ; $\underline{F}(4, 121) = .469$; $\underline{p} = .758$), which seems to imply that sex does not influence the perceived age of our virtual characters. As a second result, the effect of the Within-subjects factor Virtual characters is highly significant and shows that the virtual characters are perceived as displaying distinct ages (Wilks= .113 ; $\underline{F}(4, 121) = 237.796$;$\underline{p} < .001$). Pairwise comparisons results presented at table 2 allow to see that adult characters are indeed perceived as adults (i.e. older than 18 year-old) and significantly older than child characters.

Then, the Female adult character is perceived as slightly younger than the Male adult. In the same way, the Female child is also perceived as younger than the Male child, the latter being seen as slightly older than planned even though he is nevertheless perceived as prepubescent in average.

2 Experiment 2

Experiment 2 aims specifically at verifying the possibility of using 3D virtual characters with immersive technologies to draw up deviant sexual preference profiles. Erectile responses obtained with virtual stimuli are compared according to the belonging of participants to either a non-deviant control group (ND) or a clinical group composed of sexual aggressors against children (SAAC), as well as according to the sexual stimulus they were presented (Neutral, Male adult, Female adult, Male child and Female child).

2.1 Participants

Ten male SAAC participants were recruited to compose the clinical group (N=10), among which 9 had been formally recognized as guilty of sexual aggression against children and one admitting to have pedophilic interests and using juvenile pornography. These participants come from the Royal Ottawa Forensic programme, the *Centre de psychiatrie légale de Montréal* and the *Centre d'Étude et de Recherche de l'Université de Montréal* where they were involved in treatment or pre-sentence assessment. Fifteen non-deviant male subjects were recruited from newspaper ads to compose the ND group. These latter participants do not have a criminal record and assert that they do not have sexual interests toward children. Mean age of the SAAC group is 39.9 year-old (SD 13.6) while ND group's is of 45.5 year-old (SD 11.0); age difference is not statistically significant ($\underline{t}(23) = 1.129$, $\underline{p} = .271$). Subjects of both groups were matched according to their education level and socioeconomic status. Two participants of the SAAC group are under antiandrogenic medication to reduce their libido and seven others are taking antidepressants.

We find in the SAAC group one homosexual participant sexually attracted by male children, the remaining of this group is heterosexual and attracted by female children. The ND group is composed of 4 homosexual, one bisexual and 10 heterosexual participants.

Participants were met at the *Laboratoire de cyberpsychologie de l'Université du Québec en Outaouais* or at the *Laboratoire de cyberpsychologie de l'Institut Philippe-Pinel de Montréal*.

2.2 Materials and Measures

2.2.1 Sexual stimuli and virtual reality simulator

The virtual characters used as sexual stimuli are described in Experiment 1 and shown in figure1. These characters are animated to simulate a neutral attitude, i.e. an idle position with subtle body movements (head movements, blinking, slight rotations of the torso). These animations were developed using a motion capture system and the movements of actors wearing data suits[Ren07].

Two different virtual reality systems are used in the present study. A CAVE-type immersive system is used at the *Laboratoire de cyberpsychologie de l'Université du Québec en Outaouais*, it consists of three translucent walls onto which projectors project dynamic images [RCR$^+$09, CNSD$^+$92]. Subjects wear active stereoscopic glasses to experience the virtual stimuli in three dimensions. Head position and orientation coordinates are provided by a motion tracker to the virtual reality engine to correct images according to body movements. The other virtual reality system, which is located at the *Laboratoire de cyberpsychologie de l'Institut Philippe-Pinel de Montréal*, is based on a similar logic but uses a head mounted display to present virtual stimuli. Subjects are put in virtual immersion while their erectile response is recorded simultaneously.

2.2.2 Penile plethysmography

Sexual plethysmography (PPG) measures variations in sexual organs' blood volume, it is used particularly to assess sexual arousal. Penile plethysmography re-

	Participants' sex	Mean	Std. Deviation
Female adult character	Male	22.2632	5.79120
	Female	22.8692	3.69876
Female child character	Male	10.1579	1.21395
	Female	10.6682	1.73877
Male child character	Male	12.5789	1.98090
	Female	13.0935	2.06741
Male adult character	Male	24.4211	4.78790
	Female	25.20565	3.64391
Neutral character	Male	23.9474	8.95962
	Female	22.6542	5.19634

Table 1: Mean and standard deviation of perceived age for each five virtual characters

				95% Confidence Interval for Differences	
(I)factor1	(J)factor2	Mean Difference(I-J)	Std. Error	Lower Bound	Upper Bound
Neutral	Male adult	-2.238*	.547	-3.321	-1-155
	Female adult	.701	.582	-1.081	1.224
	Male child	9.833*	.525	8.794	10.873
	Female child	12.258*	.541	11.187	13.328
Male adult	Neutral	2.238*	.547	1.155	3.321
	Female adult	2.310*	.367	1.583	3.036
	Male child	12.071*	.341	11.396	12.747
	Female child	14.496*	.363	13.777	15.215
Female adult	Neutral	-.071	.582	-1.224	1.081
	Male adult	-2.310*	.367	-3.036	-1.583
	Male child	9.762*	.351	9.068	10.456
	Female child	12.187*	.382	11.430	12.943
Male child	Neutral	-9.833*	.525	-10.873	-8.794
	Male adult	-12.071*	.341	-12.747	-11.396
	Female adult	-9.726*	.351	-10.456	-9.068
	Female child	2.425*	.191	2.046	2.803
Female child	Neutral	-12.258*	.541	-13.328	-11.187
	Male adult	-14.496*	.363	-15.215	-13.777
	Female adult	-12.187*	.382	-12.943	-11.430
	Male child	-2.425*	.191	-2.803	-2.046

* The mean difference is significant at .001 level.

Table 2: Pairwise comparisons between virtual characters' perceived ages

quires the wearing of a thin mercury-in-rubber-strain-gauge around the shaft of the penis. This gauge is simply a small rubber tube filled with mercury forming a ring. During an erectile response, the gauge stretches and changes in the mercury column produces variations in electric conductibility which is expressed in voltage gradient.

In order to reduce inter-individual variability inherent to erectile responses, raw scores were transformed into ipsative scores, i.e. into the computation of z-scores made across the five categories of virtual characters, for each individual participant [BKD$^+$01, BKB$^+$06]. These intra-individual z-scores are used as dependent variable in the following statistical analyses.

2.3 Procedure

Once at the laboratory, subjects are briefed about the study and sign a consent form. They sign a consent form in which it is clearly stated that their results would not be used in any correctional or legal process and that they would remain confidential. It is furthermore made clear to them that they can withdraw from the study at anytime.

In order to assess the subjects' erectile potential (i.e. their maximum sexual response), erectile responses are recorded during the viewing of an heterosexual erotic movie for a period of 5-minute at the outset of the experimental trials. Then subjects are briefed and given a five-minute training period during which they are immersed in a realistic apartment furnished with various pieces of furniture. They are then simply asked to pay attention to the 3D animations they are about to be immersed with for five 120 second periods. Virtual characters are presented in the following order: Female adult, Female child, Male child, Male adult, and Neutral. Erectile response has to return to baseline between stimulus presentation. After the experience, subject is debriefed and given $50 to indemnify him.

2.4 Statistical Analyses

A repeated measures MANOVA with Groups (ND vs SAAC) as a Between-subjects factor and Virtual characters (female adult, female child, male child, male adult and neutral) as Within-subjects factor is performed. Erectile responses expressed in ipsative z-scores are used as the dependent variable. Independent T-tests are computed in the context of significant multivariate effects. An alpha level of .05 is used for all statistical tests.

2.5 Results

Figure 2 shows erectile response profiles according to Groups and Virtual characters factors. Using Wilks' Lambda criterion, the repeated measures MANOVA gives a non significant main effect for the Within-subjects factor ($Wilks = .661$; $\underline{F}(4, 20) = 2.561$; $\underline{p} = .070$), even though it is rather close to be so. However, the interaction effect between the latter and the Between-subjects factor Groups is on the other hand statistically significant ($Wilks = .489$; $\underline{F}(4, 20) = 5.235$; $\underline{p} < 0.01$). Simple effects for this interaction effect are verified from independent T-tests shown at the table 3. SAAC and ND groups differ significantly as for erectile response when facing Female child and Male adult, with SAAC participants being more sexually aroused by the first stimulus while the reverse is observed for the second one. Female adult and Male child, as well as Neutral stimuli do not statistically distinguish groups between them, even though the expected tendencies are noticed (see figure 2). The fact there are 5 homosexual or bisexual participants out of ten in the ND group, while there is only one in the SAAC group, may help to explain why the Male adult character is more distinguishing than the Female adult one. Increasing sufficiently the number of subjects in each sexual orientation category would possibly allow clearer comparisons on that matter. Also, the reason why Male child character is not distinguishing between groups is most probably attributable to the fact that there is only one participant attracted to prepubescent male child in the SAAC group. When compared to those of the ND group ($AVG = -0.419$, $SD = .456$, $testvalue = 1.27$; $\underline{t}(14) = 14.349$, $\underline{p} =< .001$) or even with those of his own group ($AVG = -0.261$, $SD = .509$, $testvalue = 1.27$; $\underline{t}(8) = 9.017$, $\underline{p} =< .001$), the score of this homosexual pedophile subject is highly statistically different, with a higher sexual arousal engendered by the Male child virtual character.

Both groups thus present distinct multivariate profiles according to the virtual characters they were immersed with. Non deviant subjects (ND) show higher sexual arousal when facing virtual characters simulating adult primary and secondary sexual character. On the other hand, subjects known for their sexual attrac-

tion to prepubescent victims (SAAC) respond more strongly to virtual stimuli mimicking sexual features belonging to children aged between 10 and 12 year-old.

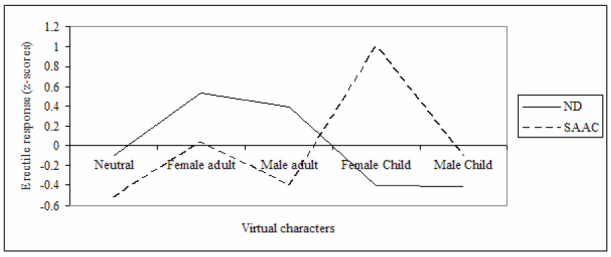

Figure 2: Erectile response profiles according to Groups and Virtual characters

3 Discussion

Our study is subject to methodological limitations and presents results that still need to be strengthened. Indeed, increasing the size of our sample is critical for us to be able to come to firmer conclusions. In order to tighten and better target our results, we will also have to control for the sexual orientation of our subjects (heterosexual, homosexual, bisexual) as well as for the exclusiveness and non exclusiveness of pedophilia. In spite of these required improvements, the preceding results point in the right direction and show the way to go.

Designing and developing virtual characters fitting specific age brackets are not easy tasks to do. Results of Experiment 1 are satisfactory enough to base a PPG study of sexual preferences on the virtual characters that we developed.

Results of Experiment 2 tend to show that virtual characters validated for their general appearance and age can prompt sexual arousal and be used to draw up sexual preference profiles discriminating between sex offenders and non deviant individuals. These discriminating physiologic patterns in themselves are also vouching in return for the validation process of the virtual characters that we developed.

3.1 Made-to-measure virtual characters

However, to more closely fit singular sexual preferences, the inherent malleability of virtual characters can be used in designing made-to-measure virtual sexual stimuli. This method could be either an alternative or a complement to a standardized set of virtual characters validated with a sample of patients coming from specific forensic clinical populations.

Two patients were met at a maximum security psychiatric hospital (*Institut Philippe-Pinel de Montréal*) by a clinical psychologist specialized in forensic assessment and treatment of sex offenders. This psychologist conducted interviews with and case file reviews of the aforementioned patients in order to draw-up individualized sexual preference profiles. These profiles were then used to inform the design of virtual characters to match the individualized preferences sketched out by the clinical psychologist. The following clinical vignettes give details about these patients and present virtual characters prepared by the clinical psychologist from a high-definition avatar generator software.

3.2 Clinical vignette one: a rapist of female adolescent

Michael, 31 years old, is serving a 2 year sentence for Forcible confinement, Use of weapon and Attempt to commit a criminal act. He is assessed as being a low functioning individual.

The victim of the index offences is a 14 year-old female, unknown to the offender. She was walking home after school. Michael grabbed her by the arm and said “You are coming with me”. She resisted and hit him with her school bag, putting an end to Michael’s attempt to isolate the victim and sexually assault her. He was arrested a couple of minutes later and police officers found a knife in his pocket. Prior to this incident, Michael reports that he spent hours watching female adolescents in parks or school yards. For many years, he would fantasize about having sex with these young females. Over the years, his fantasies became more intrusive and violent. Michael reports that when he approached the victim, he had planned to kidnap her and force her to intercourse. He planned to use his knife if the victim was to resist. However, he backed off when he encountered real resistance from the victim. In addition, Michael reports being aroused by cross-dressing and SM role plays (where he would insult and/or physically hurt his partner).

When asked to described his sexual preference, Michael talks about teenage girl (13 to 17 years old), with small breasts (A cup. During phallometric testing, he repeatedly responded with greater erection to audio stimuli depicting sex with pre-pubescent girl then to audio stimuli depicting consensual sex between adults. He reports being attracted to domination/humiliation of his partner.

	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Neutral	23	.174	.41399	.29511	-.19649	1.02447
Female adult	23	.226	.50366	.40478	-.33369	1.34101
Male adult	23	.047	.79210	.37777	.01062	1.57358
Female child	23	.000	-1.39765	.29993	-2.01810	-.77719
Male child	23	.184	-.31033	.22659	-.77908	.15841

Table 3: Independent T-tests for the interaction effect between Groups and Virtual Characters

Figure 3: Virtual characters depicting a female adolescent designed according to the sexual preferences expressed by the patient whose case is described in clinical vignette one (www.behavrsolution.com).

Figure 4: Virtual characters depicting a female adult designed according to the sexual preferences expressed by the patient whose case is described in clinical vignette two (www.behavrsolution.com).

3.3 Clinical vignette two: a rapist of female adolescents and adults

Domingo, is a 33 year-old latino-canadian serving a nine year sentence for Sexual Assault (one count) and Armed Sexual Assault (four counts). All his victims were female, aged 16 to 25 and unknown to the offender. During a period of two months, Domingo cruised around the city in his car, looking for potential victims. He selected the women based on availability and looks (nice firm behind, big breasts and sexy clothing). Domingo followed the victims until they reached a secluded area. He then pushed the victims against a building and forced them to diverse sexual acts (including fondling, kissing, fellatio, and penetration). Although he was charged for Armed Sexual Assault, no weapon was ever used during the offences. However, on four occasions, Domingo pretended to be armed with a knife. Domingo used death threats and physical violence (strangling, punching) during the offenses.

At plethysmographic testing, Domingo presented a deviant profile responding higher to sexual assault with violence scenarios than to consensual heterosexual scenarios.

The resulting virtual characters were not validated yet with the concerned patients. They will be in a future study that will make use of psychophysiological and subjective measurements of sexual response and feeling of presence. Behaviors and emotions that match these patients' criminal *modus operandi* and sexual preferences will then be given to the individualized virtual characters.

4 Conclusion

In conclusion it can be said that using virtual characters for forensic assessment of criminal paraphilias appears to be possible and even preferable than using standard stimuli with PPG. Virtual characters are realistic enough, their use is more ethical than photographs or videos of real individuals and their malleability is a very interesting asset when it comes to fit highly specific sexual preferences. Furthermore they could eventually throw bridges between assessment and treatment of sex offenders that would be based on interactive role plays enacted in virtual re-

ality [Ren07, RDG08].

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