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"I Like the Way You Move": Validating the Use of Point-Light Display Animations in Virtual Reality as a Methodology for Manipulating Levels of Sexualization in the Study of Sexual Objectification

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Sexual objectification of others has seen a growing research interest in recent years. While promising, the field lacks standardized stimuli, resulting in a confusion between sexualization and sexual objectification, which limits the interpretability of published results. In this study, we propose to use point-light display (PLD) as a novel methodology for manipulating sexualization levels as a first step toward isolating movement from other visual cues (e.g., clothing or physical appearance) for studying effects of sexual objectification of others. To do so, we first developed 8 virtual reality animations varying on 3 dimensions: 1) nature of movement (dance vs. walk), 2) level of sexualization (low vs. high), and 3) animation speed (slow and fast). Then, we validated these stimuli with perception ratings from 211 participants via an online survey. Using mixed linear regression models, we found evidence that our manipulation was successful: while participants took longer, were less accurate, and less confident in their response when confronted with a dancing, sexualized PLD, they also rated it as significantly more sexualized. This latter effect was stronger for participants perceiving a woman dancing compared to participants who perceived other genders. Overall, participants who reported more frequent sexual objectification behaviors also perceived the animations as more sexualized. Taken together, these results suggest that sexual suggestiveness can be manipulated by rather simple movement cues, thus validating the use of PLD as a stepping stone to systematically study processes of sexual objectification. From there, it is now possible to manipulate other variables more precisely during immersions in virtual reality, whether by adding a skin to the animated skeleton, by situating the PLD into different context, by varying the amplitude and the nature of the movements, or by modifying the context of the virtual environment.

Keywords: virtual reality, biological movement perception, point-light display, sexual objectification, sexualization

INTRODUCTION

Sexual objectification has received increased research focus following the publication of the Report of the American Psychological Association (APA) Task Force on the Sexualization of Girls (American Psychological Association, 2007), which drew attention and interest for the problematic, but also to the shortcomings of the scientific literature on the subject (Ward, 2016). Since, numerous studies have documented its psychological and social consequences, both in terms of self-objectification (Karsay et al., 2018) and, more recently, objectification of others (Bernard et al., 2018a). While promising, this latter field of inquiry suffers from methodological limitations that casted doubt on the validity of its results (e.g., Zogmaister et al., 2020), mainly because of its lack of standardized stimuli, opening the door for confounding factors and competing interpretations. In this study, we propose a novel methodology to create stimuli for the systematic study of the effects of sexual objectification of others using the point-light display (PLD) paradigm in the study of biological movement.

According to objectification theory (Fredrickson and Roberts, 1997), sexual objectification of women would be the direct result of the exposure to the increasingly sexualized depictions of women (and a lesser extend of men) in medias. Sexualization would occur when the attention of a perceiver is focused on the sexual characteristics or functions of a person, on which her value is solely evaluated (Fasoli et al., 2018). This, in turn, would lead to her sexual objectification, where her sexual body parts or functions are separated from her person, leading her to be treated as an object or a mean to reach an end for others, i.e., their sexual desire, pleasure or satisfaction (Gervais et al., 2013). As such, once objectified, a person would be dehumanized, not warranting the same level of moral consideration as a whole human, thus facilitating a wide range of behaviors toward her, from objectifying gazes or inappropriate sexual innuendo on one end to sexual assault or exploitation on the other end. It would also affect a wide range of attitudes and intentions toward objectified women. For example, women that are sexually objectified are perceived not only as less human, be also more responsible as a victim, be it in the context of sexual assault (Loughnan et al., 2013), intimate partner violence (Pacilli et al., 2017) or sexual harassment (Bernard et al., 2018b; Gramazio et al., 2018), which in turn predicted lower willingness to help the victim as a bystander. Better understanding the link between sexualization and objectification could thus help us diminish sexual violence against women by reducing victim blaming.

This link between sexualization and objectification have been studied from two distinct perspectives in the literature (Bernard et al., 2020). A first line of inquiry focused on the consequences of sexual objectification, namely on how individuals perceive sexualized women and how it affects the way they attribute personality characteristics normally associated with humanness. Studies reported that sexualized women are perceived as possessing less competence, less warmth, less agency, and less moral potency compared to non-sexualized women or sexualized men (Heflick and Goldenberg, 2009; Gray et al., 2011; Heflick et al., 2011; Bernard and Wollast, 2019). Other studies focused on the cognitive and perceptual processes of sexual objectification. Using eye tracking technology (Gervais et al., 2013), the Dot Probe task (Holland and Haslam, 2013), the Oddball task (Vaes et al., 2019), or the Parts-versus-whole-body recognition paradigm (Gervais et al., 2012), these studies have found indications that women that are sexualized are reduced to their body parts by the perceivers. Going further, the Sexualized-Body-Inversion Hypothesis (Bernard et al., 2012) proposed that women's sexualized body are processes as objects by the brain. In a series of studies using the Inverted Body Recognition Task (IBRT), Bernard and colleagues (Bernard et al., 2015; Bernard et al., 2017; Bernard et al., 2019) found behavioral and neurological evidence that women presented in a sexualized way are processed in an analytical rather than configural way, i.e., similar to an object rather than a person. While interesting, these studies have been criticized, particularly those using the IBRT, for the stimuli they used (Tarr, 2013; Schmidt and Kistemaker, 2015; Zogmaister et al., 2020). We think this critique could be applied to the field of sexual objectification of others.

As noted by Ward (2016), there are currently no standardized measures for sexual objectification. This is true not only for self-reported measures, but also for the stimuli used in the studies previously mentioned. Moreover, sexualization and sexual objectification are often used interchangeably in the literature (Fasoli et al., 2018). These two points taken together have a serious impact on the manipulation of sexualization that limit the interpretability of the results. This manipulation took numerous form between studies: by using pictures (Bernard et al., 2012), videos (Bernard et al., 2018a), or written vignettes (Loughnan et al., 2010); by changing the skin-to-cloth ratio of the individuals portrayed (Cogoni et al., 2018), by focusing the visibility on their body or their face (Bernard et al., 2018b), by changing the suggestiveness of their posture (Bernard et al., 2019; Bernard and Wollast, 2019), by adding make-up (Pacilli et al., 2017) or changing the context (e.g., the person is seated in a bar or laid down on a bed; Pacilli et al., 2017), or simply by giving instructions to participants to focus on the appearance or the personality of the person while processing the stimuli (Heflick and Goldenberg, 2009; Heflick et al., 2011). This results not only in great variability between studies, but also within studies: the stimuli used are rich and complex, with multiple dissimilarity between each experimental condition. This have an impact not only for perceptual processes such as the one study using the IBRT (Zogmaister et al., 2020), where simple body silhouettes are usually used, but also for those studying the consequences of sexual objectification through humanness attribution. Using these manipulations, it becomes difficult to specifically identify which elements of a stimulus leads to sexual objectification and to quantify the magnitude of their contribution to the effect observed in the experiment. Moreover, it becomes practically impossible to properly isolate sexualization as the driving factor for objectification from other social information processes. Any uncontrolled cues present in complex visual stimuli (e.g., hair style, waist-to-hip ratio, skin color/tone, piercing/tattoos, etc.,) could trigger other biases for the perceiver (e.g., racial or gender stereotypes, sexual preferences, physical attraction, etc.,) and results in objectification without being caused by sexualization.

TABLE 1 | Sociodemographic characteristics of participants.

Characteristics		*n*	%
Gender	Male	51	24.76
	Female	154	74.76
	Other	1	0.49
Sexual orientation	Exclusively heterosexual	148	71.84
	Predominantly heterosexual	33	16.02
	Equally heterosexual and homosexual	7	3.40
	Predominantly homosexual	8	3.89
	Exclusively homosexual	7	3.40
	Other	3	1.46
Ethnicity	Caucasian	185	89.81
	African	4	1.94
	Arabic	3	1.46
	Asian	4	1.94
	Latino	4	1.94
	Other	6	2.91

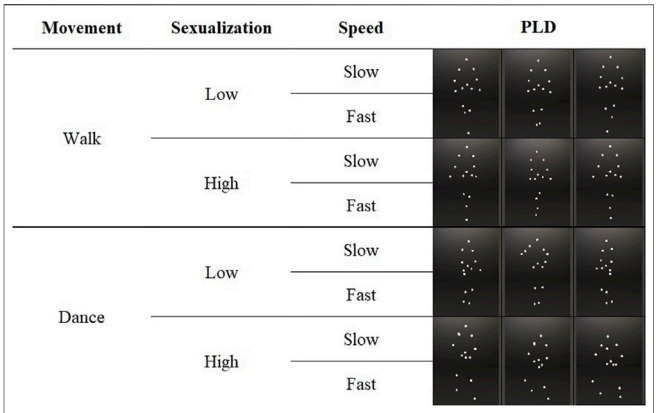

FIGURE 1 | Stimulus matrix for the PLD animations.

For these reasons, it is imperative to develop and validate a standardized methodology for manipulating levels of sexualization. Since sexual objectification is a highly, multidetermined phenomenon, a standardized methodology should allow to isolate as much as possible parameters associated with sexualization, and thereafter systematically identify specific elements that contribute to sexualization and objectification. Based on results from (Bernard et al, 2019) and (Bernard and Wollast, 2019) suggesting that posture suggestiveness might drive sexual objectification rather than skin-to-cloth ratio, we propose to use point-light display as a first step toward isolating movement variables from those associated with appearance.

Visual processing of biological movement, i.e., motion from a living organism compared to non-living objects, plays a central role in social cognition, helping understanding emotion states and intentions through non-verbal communication (Pavlova, 2012). As such, research shows that this ability is present in infants as young as 5 months old (Miller et al., 2018) and that disorders characterized by social cognition deficit, such as autism spectrum disorder (Todorova et al., 2019; Federici et al., 2020) or schizophrenia (Okruszek and Pilecka, 2017), are associated with lower performances on numerous tasks measuring biological movement perception, including the PLD.

PLD was first developed by Johansson (1973) for isolating as much as possible and studying the minimal information required by participants to process biological movement. It has a clear advantage over other tasks: by only presenting light points at the major articulations of a moving actor (hips, knees, ankles, shoulders, elbows, and wrists) on a black screen, motion is effectively isolated. Participants have access to minimal structural information and no access to shape, color, or other appearance features. Numerous studies have since then replicated the original results (Pavlova, 2012) by showing that individuals can accurately recognize a wide range of locomotory (e.g., walking, running, going up a staircase), instrumental (e.g., using a hammer, dribbling a basketball, picking up a box), and social (e.g., dancing, boxing, handshaking) actions (Dittrich 1993). Participants are also able to correctly identify emotions (Dittrich et al., 1996; Atkinson et al., 2004; Clarke et al., 2005; Chouchourelou et al., 2006; Alaerts et al., 2011) and distinguish themselves from people they know and strangers (Loula et al., 2005; Prasad and Shiffrar, 2009; Blasing and Sauzet, 2018). Without any other information about the person, participants are also able to reliably infer personality traits (Thoresen et al., 2012), intentions (Sebanz and Shiffrar, 2009), vulnerability (Gunns et al., 2002), gender (Kozlowski and Cutting, 1977; Mather and Murdoch, 1994) and sexual orientation (Johnson et al., 2007) of the PLD. Finally, attractiveness ratings of women-based walking PLD are highly correlated to those based on videos (Morrison et al., 2018) underscoring the importance of movement in such judgments.

Dance movements are good candidate for manipulating levels of sexualization for studying objectification of others. Dance is easily sexualized: it has been observed as part of courtship practices among numerous cultures and used to display beauty and sexual attractiveness (Fink et al., 2015). As such, effects of music video sexualization on objectification has been documented in the literature (Ward et al., 2015). Music videos has also been successfully used to manipulate sexual objectification in previous studies (Bernard et al., 2018a). Finally, studies have found that participants are not only able to recognize dance movement on PLD (Dittrich, 1993; Blasing and Sauzet, 2018), both also to detect emotions displayed through these dancing PLDs (Dittrich et al., 1996; Brownlow et al., 1997).

The goal of this study was to validate the use of PLD as a methodology for manipulating levels of sexualization for the systematic study of variables leading to sexual objectification in virtual reality (VR). As a first step, movement cues were isolated from structural information and appearance features using PLD animations. Motion capture technology was favored over video recording of actors to enable us to build on these animations using VR to study other variables associated to sexual objectification, by adding a skin to manipulate physical appearance (e.g., gender, skin-to-cloth ratio, body mass index, skin color), by situating the animations into different contexts, or both.

TABLE 2 | Mean and standard deviation of each outcome by stimuli conditions.

Movement	Sexualiz. Manip	Speed	Reaction time (seconds)		Identification accuracy (%)		Response confidence (%)		Perceived sexualization		Gender attributed (%)		
			M	SD	*M*	*SD*	*M*	*SD*	*M*	*SD*	Male	Female	Other
Walk	Low	Slow	6.07	4.06	0.98	0.15	94.25	9.65	0.95	1.21	26.54	53.55	19.91
	Low	Fast	6.07	4.15	0.97	0.17	93.73	12.28	0.66	1.02	28.91	42.18	28.91
	High	Slow	7.12	4.84	0.99	0.12	9.89	14.45	2.62	1.68	12.80	72.04	15.17
	High	Fast	6.81	4.69	0.99	0.12	92.04	13.13	2.19	1.53	16.59	67.77	15.64
Dance	Low	Slow	6.98	4.77	0.97	0.18	91.65	12.17	1.01	1.04	27.01	45.97	27.01
	Low	Fast	7.10	5.18	0.98	0.14	92.23	11.79	1.04	1.12	33.18	44.55	22.27
	High	Slow	9.31	6.60	0.82	0.39	81.55	21.26	3.21	1.60	36.97	43.60	19.43
	High	Fast	9.08	6.63	0.80	0.40	82.00	21.32	3.09	1.61	35.07	42.65	22.27

M = Mean, SD = Standard deviation, Sexualiz. Manip. = Sexualization manipulation

The validation process was performed as follow. First, processing of the stimuli and sexualization manipulation were performed across two movements (i.e., dancing and walking) and two animation speed (i.e., slow and fast). This last manipulation was added to make sure correct identification of the stimuli was driven by the sexual cues contained in each animation and not by differences in the amount of information available in each, i.e., how much each individual point move relatively to the other points in a PLD (Hill and Pollick, 2000). Second, convergent validity was tested by using past behaviors of sexual objectification and attitudes supporting such behaviors as predictors of ratings of sexualization across stimuli. Finally, the effect of gender perception on sexualization ratings was compared across stimuli.

First, manipulation checks were performed to make sure processing of the stimuli was similar in terms of processing time, correct identification rates, and certainty in response based on the nature of the movement, the level of sexualization, and the animation speed. We expect to have main effect for movement type and sexualization manipulation on perception of sexualization, such as that the dancing and the high sexualization animations will be perceived as more sexualized than the walking or the low sexualization ones, regardless of animation speed. Self-reported behaviors of sexual objectification and positive attitudes toward such behaviors should positively predict perception of sexualization across conditions. Finally, we expect that attribution of female gender to a PLD will predict higher sexualization ratings compared to the other genders, again regardless of conditions.

MATERIALS AND METHOD

Participants

A total of 211 adults participated in an online, anonymous study. Five participants were excluded from analysis because they failed to respond correctly to the three attention verification questions (see below). The final sample was comprised of 51 men (24.8%), 154 women (74.8%), and one non-binary individual (0.5%). Sociodemographic characteristics of the final sample can be found in **Table 1**. Participants were aged between 18 and 77 years old ($M = 29.63$, $SD = 11.67$). The majority declared being exclusively or mostly heterosexual (85.4%) and being of Caucasian descent (88.3%). More than half of the sample (60.68%) reported being student (all levels of education combined) at the time of data collection.

Procedure

Eight 3D animations were developed for this study. First, raw animations created using motion capture technology (i.e., Vicon 8i and Optitrack Prime) were bought from Unito Motion Capture Studio™ on the Unity Asset Store™. These animations were then adapted to our research needs for future VR applications using Unity™ software. Specific dance and walk movements were isolated and looped into complete sequences of 30 s each. Levels of sexualization were

manipulated for these two types of movement (i.e., amplitude of hips movement, hands touching hair, breasts, or hips). This manipulation was validated and adapted based on the feedback of an independent sample of 20 participants both for the identification of the action and the level of sexualization. To ensure that discrimination between these animations was driven by the nature of the movement and the level of sexualization and not simply by the amount of information available in the PLD (Hill and Pollick, 2000), movement speed was also manipulated. Each animation was presented twice, once at normal speed and once 20% slower, for a total of eight stimuli (**Figure 1** for the stimulus matrix). These animations were presented using a PLD composed of 14 white spheres placed at the principal articulations of the human body (2 at ankles, knees, hips, wrists, elbows, and shoulders, 1 at pelvis and neck). The PLD was facing the camera on a dimly lighted black background. Each stimulus was exported in video format for online presentation. A timestamp overlay (hh:mm:ss:ms) was also added at the bottom of each video as a timing reference for the identification task. These animations are available into the online supplemental material of this paper.

Participants were recruited via an anonymous link distributed online. Recruitment ads were made on social media, targeting student associations, and psychology and sexology research labs from the province of Quebec. People were also invited to share the recruitment ads on their personal page, giving us access to a non-student population. Finally, the ad was sent by email through a listserv of psychology researchers to be distributed on their network. The questionnaires were answered online on LimeSurvey with data stored on secured, institutional servers. After agreeing to the informed consent form and giving basic sociodemographic information, participants were successively presented with all of eight stimuli previously described in a fully randomized order. For each stimulus, participants were asked to stop the video when they recognized the action portrayed by the PLD, to report the timestamp, and identify the action using a short, open-ended question. Also, they were asked to attribute, as spontaneously possible and without deliberation, a gender to the PLD and to rate the level of sexualization of each action. Then, participants completed two questionnaires, the Interpersonal Sexual Objectification Scale - Perpetrator Version, Revised (ISOS-PR) and the short version of the Balanced Inventory of Desirable Responding (BIDR-6). Three instructed response items (e.g., 'This question is an attention check. Please answer three to this question.') were inserted among the items of each questionnaire in the online survey with the same measurement scale to ensure that participants maintained adequate attention when completing the study (Gummer et al., 2018). Participants were excluded from data analysis if they failed to answer more than one of these questions. The project received ethical approval from the university's institutional review board.

Measures

Stimulus Processing

For each stimulus, participant had to 1) report the time they took to identify the action (expressed in seconds from the start of the stimulus to the moment they pressed stop), 2) identify the nature of the action they perceived, 3) report their confidence in their answer (expressed as a percentage), 4) attribute a gender to the PLD (from three choices: male, female, other/don't know), and 5) rate the level of sexualization of the action (perceived sexualization). Identification of the action was recoded as a measure of accuracy (success/error) based on the two broad categories of movement presented (i.e., dance and walk). The sexual objectification was assessed using two questions responded on a 7-point Likert scale ranging from 0 ("not at all") to 6 ("very much"): "How much do you think the attitude of the character in this video was . . . " 1) "sexualized", 2) "sexy". Scores were then averaged for both questions.

TABLE 3 | Mean and standard deviation for self-reported questionnaires.

	M	*SD*
ISOS-P: Behaviors	1.49	0.30
ISOS-P: Attitudes	2.47	0.47
BIRD-6	5.69	2.50

ISOS-P = Interpersonal Sexual Objectification Scale—Perpetration Version, BIRD-6 = Balanced Inventory of Desirable Responding version 6

Interpersonal Sexual Objectification Scale—Perpetrator Version, Revised

The revised version of the ISOS-P (Gervais et al., 2018; Costello et al., 2019) was used to determine the convergent validity of the developed stimuli. This questionnaire measures frequency of sexual objectification behaviors in the last year (14 items) and endorsement of positive attitudes toward sexual objectification (seven items) using a Likert scale ranging from 1 ("never" for behaviors and "totally disagree" for attitudes) to 5 ("almost always" for behaviors and "totally agree" for attitudes).

Balanced Inventory of Desirable Responding–6th Edition (BIDR-6)

The Impression Management subscale of the BIDR-6 (D'Amours-Raymond, 2011; Paulhus, 1984) was used to measure social desirability in our sample. The subscale is composed of 13 items, responded on a 7-point Likert scale. Answers are dichotomously recoded so that only extreme scores (6-7 or 1-2 on reversed items) contribute to the total score (ranging from 0 to 13).

Data Analysis

Generalized mixed linear and logistic models with random intercepts were computed to analyse response time (RT), accuracy, confidence, and perceived sexualization using SPSS 25. This type of models has the advantage over general linear models (such as repeated measures ANOVA) as they can handle missing data and can include perceivers effect measured in each condition. Thus, two moderation models were also tested: the effect of gender attributed to the PLD, and the effect of behaviors and attitudes on perceived sexualization of the PLD. The three condition variables (movement, manipulation of sexualization, and speed) were effect coded to better test their main effect and interactions while Gender attribution was dummy coded with "Female" as the reference

TABLE 4 | Mixed linear models for predicting main outcome by conditions.

Predictors	Reaction time			Identification accuracy			Response confidence			Perceived Sexualization		
	b	*T*	*p*	*b*	*χ2*	*p*	*b*	*t*	*p*	*b*	*t*	*p*
Participant gender	−0.21	−0.70	0.485	−0.15	0.35	0.553	2.76	3.10	0.002[a]	−0.24	3.11	0.002[a]
Movement	1.48	5.65	< 0.001[a]	−1.37	19.86	< 0.001[a]	−5.44	−7.08	< 0.001[a]	0.51	7.48	< 0.001[a]
Sexualiz. Manip.	0.63	2.41	0.016	−0.79	6.63	0.010	−2.89	−3.76	< 0.001[a]	1.87	27.69	< 0.001[a]
Speed	−0.10	−0.39	0.698	0.06	0.04	0.851	−0.25	−0.33	0.744	−0.19	−2.84	0.005[a]
Movement*Sexualiz. Manip.	0.45	0.86	0.390	−2.82	20.87	< 0.001[a]	−3.6	−2.34	0.019	0.56	4.14	< 0.001[a]
Movement*Speed	0.18	0.33	0.738	0.30	0.24	0.623	−0.20	−0.13	0.889	0.31	2.26	0.024
Sexualiz. Manip.*Speed	−0.47	−0.89	0.372	−0.26	0.18	0.672	0.82	0.54	0.593	−0.13	−0.94	0.348
Movement*Sexualiz. Manip.*Speed	−0.32	−0.31	0.758	-−0.92	0.55	0.457	−0.87	−0.28	0.777	−0.03	−0.10	0.919

Sex. Manip. = Sexualization manipulation;
[a]*Significant at Bonferroni corrected level:* p < *0.006*

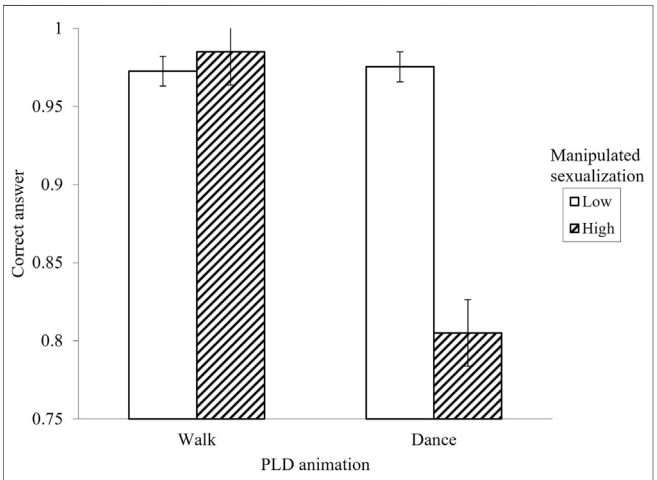

FIGURE 2 | Identification rates (with 95% confidence interval) of PLD movement animation by level of manipulated sexualization.

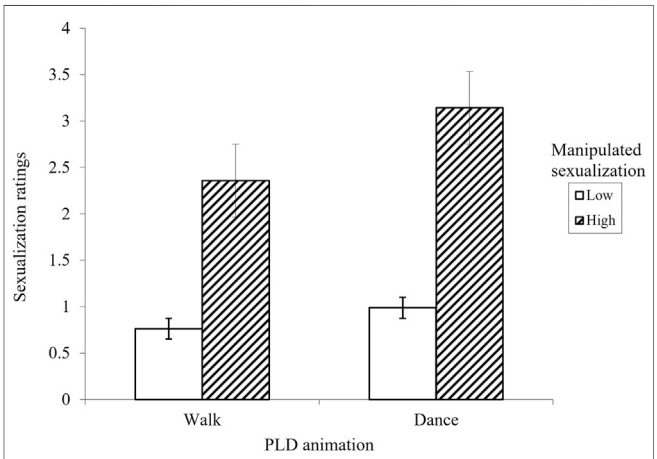

FIGURE 3 | Sexualization ratings (with 95% confidence interval) of PLD movement animation by level of manipulated sexualization.

category. To counter the effect of dummy of coding on interpretability of regression coefficient, main effects and interaction terms were added following a stepwise procedure in a hierarchical model. Continuous variables (Behaviors and Attitudes) were mean centered before analysis. Participant gender was also added to the model to control for perception differences between men and women. Family wise error rates were controlled using Bonferroni correction (see the relevant table for each analysis for the alpha threshold used).

RESULTS

Mean and standard deviations per condition for each outcome can be found in **Table 2**, while the same statistics for self-report questionnaires can be found in **Table 3**.

Processing of the Stimuli

Three models were computed to test whether the stimuli were processed as easily processed by the participants (**Table 4** for complete model information). Significant RT differences were found between stimuli based on movement type and manipulation of sexualization. Participants took significantly more time (b = 1.48, t (1630) = 5.65, $p < 0.001$) to identify the action when a dancing PLD was presented compare to a walking one. Level of sexualization didn't significantly impact RT once corrected for family wise error rates (b = 0.63, t (1630) = 2.41, p = 0.016). Animation speed had no impact on RT (b = −0.10, t (1,630) = −0.39, p = 0.698). No significant interaction was found in this model.

For identification accuracy, significant differences were found based on movement (b = 1.33, $\chi^2(1) = 18.35$, $p < 0.001$), but not based on level of sexualization following Bonferroni corrections ($b = 0.79$, $\chi^2(1) = 7.05$, $p = 0.010$). Yet, the effect of movement was significantly moderated by the level of sexualization (b = 2.88, $\chi^2(1)$ = 20.87, $p < 0.001$). Simple slope analysis (**Figure 2**) revealed that identification errors were mostly made in the high sexualization dance condition. In low sexualization conditions, accuracy ratings were similar (b = 0.11, z = 0.25, $p = 0.800$). However, participants were more prone to make error trying to identify the high sexualization dance compare to the high sexualization walk (b = −2.77, z = −6.43, $p < 0.001$). Again,

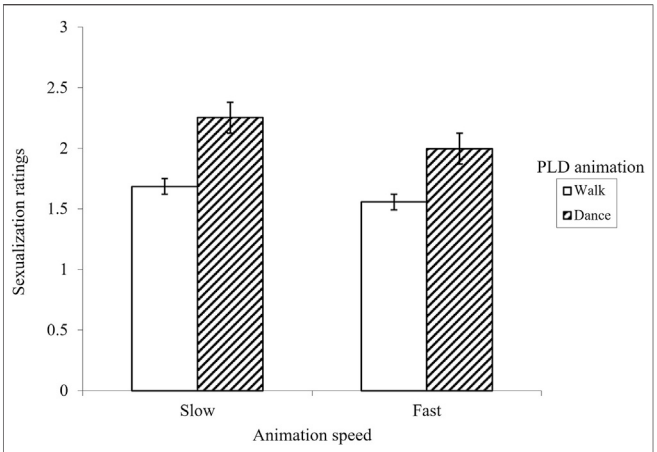

FIGURE 4 | Sexualization ratings (with 95% confidence interval) for animation speed by PLD movement animation.

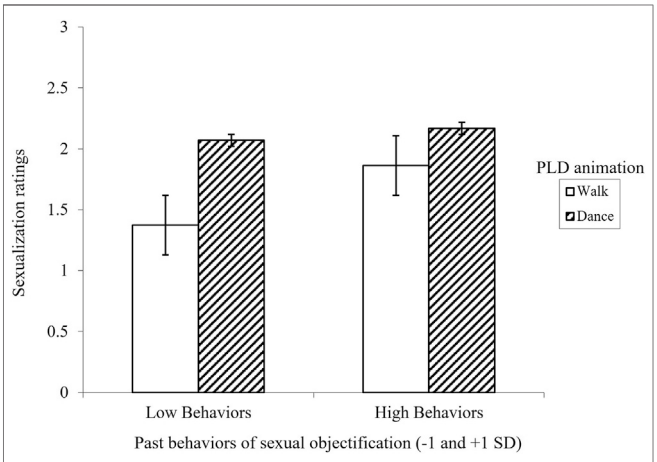

FIGURE 5 | Sexualization ratings (with 95% confidence interval) for low and high past behaviors of sexual objectification by PLD movement animation.

TABLE 5 | Mixed linear model for predicting perceived sexualization by conditions and past behaviors of sexual objectification.

Predictors	Perceived sexualization		
	b	*t*	*p*
Participant gender	−0.17	−1.96	0.050
Movement	0.50	7.38	< 0.001[a]
Sexualiz. Manip.	1.88	27.70	< 0.001[a]
Speed	−0.20	−3.00	0.003[a]
ISOS-P: Behaviors	0.03	3.26	0.001[a]
BIDR-6	−0.01	−1.04	0.299
Movement*ISOS-P: Behaviors	−0.05	−2.88	0.004[a]
Sexualiz. Manip.*ISOS-P: Behaviors	0.01	0.60	0.552
Speed*ISOS-P: Behaviors	−0.01	−0.37	0.710
Movement* Sexualiz. Manip.*ISOS-P: Behaviors	−0.03	−0.84	0.399

ISOS-P = Interpersonal Sexual Objectification Scale—Perpetration Version, Sexualiz. Manip. = Sexualization manipulation;
[a]*Significant at Bonferroni corrected level:* p < *0.005*

TABLE 6 | Mixed linear model for predicting perceived sexualization by conditions and attitudes favorable to sexual objectification.

Predictors	Perceived sexualization		
	b	*t*	*p*
Participant gender	−0.11	−1.44	0.149
Movement	0.51	7.56	< 0.001[a]
Sexualiz. Manip.	1.87	27.98	< 0.001[a]
Speed	−0.19	−2.86	0.004[a]
ISOS-P: Attitudes	0.08	7.24	< 0.001[a]
BIRD-6	−0.02	−1.67	0.092
Movement*ISOS-P: Attitudes	−0.03	−1.44	0.149
Sexualiz. Manip.*ISOS-P: Attitudes	0.03	1.41	0.158
Speed*ISOS-P: Attitudes	−0.01	−0.47	0.637
Movement* Sexualiz. Manip.*ISOS-P: Attitudes	−0.04	−0.95	0.341

ISOS-P = Interpersonal Sexual Objectification Scale—Perpetration Version, Sexualiz. Manip. = Sexualization manipulation;
[a]*Significant at Bonferroni corrected level:* p < *0.005*

animation speed had no impact on identification accuracy. No other interaction was found to be significant in this model.

Significant differences were found between condition on participants' response confidence. A main effect for movement ($b = -5.44$, t (1,621) = −7.08, $p < 0.001$) and level of sexualization ($b = -2.89$, t (1,621) = −3.76, $p < 0.001$) were found. Participants were more confident in their response toward walking PLDs and when the level of sexualization was low. Again, animation speed had no impact on response confidence between conditions. No interaction was found to be significant in this model.

Finally, we tested whether our manipulation was successful by comparing perceived sexualization of the PLD between conditions. A significant main effect of manipulation confirmed that was the case: regardless of the animation, PLD of the high sexualization conditions were rated as more sexualized than those of the low conditions (b = 1.87, t (1,611) = 27.69, $p < 0.001$). Dancing PLD were also rated as more sexualized than the walking one (b = 0.51, t (1,611) = 7.48, $p <$ 0.001). Yet, a significant movement by sexualization manipulation was found (b = 0.56, t (1,611 = 4.14, $p < 0.001$), indicating that the manipulation was more successful when applied to a movement more readily sexualized. Simple slope analysis (**Figure 3**) showed that while the manipulation was successful for the walking animation (b = 0.23, t = 2.34, p = 0.020), the difference in perceived sexualization was bigger for the dancing PLD (b = 0.78, t = 8.20, $p < 0.001$). Speed had an unexpected effect on perception of sexualization, with slower animations being rated as more sexualized than faster ones (b = −-0.19, t (1,611) = −2.84, p = 0.005). A significant interaction with movement type (b = 0.31, t (1,612) = 2.26, p = 0.024) indicates that this effect was significant only for the dancing PLDs ($b = -0.26$, $t = -3.77$, $p < 0.001$), but not for the walking ones (b = -−0.13, $t = -1.90$, p = 0.058; **Figure 4**). No other interaction was found significant in this model.

Convergent Validity

Convergent validity was first tested with past behaviors of sexual objectification while controlling for the effect of social desirability on self-reporting. Past behaviors were a significant, positive predictor of

TABLE 7 | Mixed linear model for predicting perceived sexualization by conditions and gender attributed to the point-light display.

Predictors	Perceived sexualization		
	b	***t***	***p***
Participant gender	−0.15	−2.04	0.041
Movement	0.61	9.33	< 0.001[a]
Sexualiz. Manip.	1.78	27.55	< 0.001[a]
Speed	−0.16	−2.48	0.013
Gender: Other vs. Female	−1.11	−13.24	< 0.001[a]
Gender: Male vs. Female	−0.62	−8.09	< 0.001[a]
Movement*Gender: Other vs. Female	0.13	0.74	0.462
Movement*Gender: Male vs. Female	−0.11	−0.72	0.472
Sexualiz. Manip.*Gender: Other vs. Female	−0.56	−3.26	0.001[a]
Sexualiz. Manip.*Gender: Male vs. Female	−0.07	−0.43	0.664
Speed*Gender: Other vs. Female	0.21	1.26	0.208
Speed*Gender: Male vs. Female	0.18	1.20	0.230
Movement* Sexualiz. Manip.*Gender: Other vs. Female	0.36	1.06	0.291
Movement* Sexualiz. Manip.*Gender: Male vs. Female	−0.41	−1.31	0.191

Sexualiz. Manip. = Sexualization manipulation;
[a]*Significant at Bonferroni corrected level:* p < *0.004*

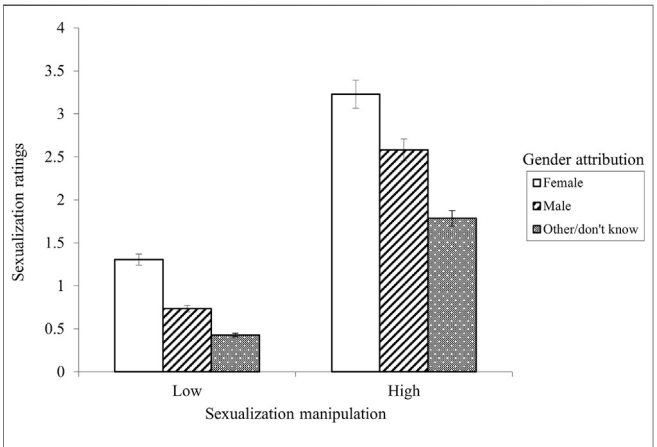

FIGURE 6 | Sexualization ratings (with 95% confidence interval) for level of manipulated sexualization by gender attributed to the PLD.

ratings of sexualization of the PLDs (b = 0.03, t (1,585) = 3.26, p < 0.001). Yet, this effect was moderated by the movement condition (b = −0.05, t (1,585) = −2.88, p = 0.004): while past behaviors was not a significant predictor for dancing PLDs (b = 0.01, t = 1.01, p = 0.314), participants reporting more sexual objectification behaviors significantly rated the walking PLDs as more sexualized than those reporting less behaviors (b = 0.06, t = 5.04, p < 0.001; **Figure 5**). No other significant interaction was found in this model (see **Table 5**).

The same analysis was performed with attitudes supporting sexual objectification. Attitudes were also a significant, positive predictor of ratings of sexualization of the PLDs (b = 0.08, t (1,609) = 7.24, p < 0.001). No significant interaction was found in this model, meaning that the effect of attitudes was the same, regardless of the condition (**Table 6**).

Gendered Sexualization

The impact of gender attribution to the PLD between conditions on ratings of sexualization was tested using a hierarchical model (**Table 7**). First, main effects of condition and gender were introduced in the model. Attributing a "female" gender to PLD was associated with significantly higher ratings of sexualization compared to both "male" (b = −0.63, t (1,613) = −8.09, p < 0.001) and "other/don't know" attribution (b = −1.11, t (1,613) = −13.24, p = 0.004). Second, interaction between gender and conditions were introduced to the model. A significant interaction between attribution of a "other/don't know" gender and the sexualization manipulation was found (b = −0.56, t (1,607) = −3.26, p = 0.001). Simple slope analysis (**Figure 6**) revealed that the sexualization manipulation had a stronger effect when participants attributed a "female" gender (b = 1.92, t = 21.43, p < 0.001) compared to a "other/don't know" gender (b = 1.36, t = 9.37, p < 0.001). No other interaction was significant at this level. Finally, we tested whether the previously found movement by sexualization manipulation interaction was moderated by the gender attributed to the PLD. This three-way interaction wasn't significant, both when comparing "female" with "male" (b = 0.36, t (1,604) = 1.06, p = 0.291), and with "other/don't know" (b = −0.41, t (1,604) = −1.31, p = 0.191).

DISCUSSION

The main goal of this study was to validate a new methodology for the development of stimuli for the systematic study of sexual objectification. Using the PLD paradigm, we developed human-like animations, manipulating both the nature of the movement (i.e., walking or dancing) and the level of sexualization (i.e., low or high) in the absence of any visual cues about physical appearance. Results show that our manipulations were successful. Stimuli with higher levels of sexualization were rated as more sexualized than those with lower levels. Moreover, a multiplicative effect was observed: the manipulation of sexualization was more effective for a movement that is more easily associated with a sexual connotation, namely dancing compared to walking (Fink et al., 2015). While differences in processing were found between stimuli,

the small amplitude of these differences could not explain away the observed effects of our manipulation. As it could be expected from the literature on PLD, more complex action, be it in terms of type of movement or level of sexualization, took longer to be recognized. This is not surprising as locomotory movements, such as walking, are more easily identified than instrumental or social ones, such as dancing (Dittrich, 1993). Adding a sexualized attitude to the dancing PLD lead participants to feel less confident in their response and to be most likely to make identification errors, with accuracy rates averaging around 80.5% in these conditions compared to the 97.5% for other conditions. Performing the analysis on ratings of sexualization by removing trials with identification error did not change the results. While this difference in error rates could be seen as problematic, one must note that these percentages are equivalent or higher to what is usually found in other studies (e.g., Alaerts et al., 2011). Also, these error rates were obtained with the PLD presented in front of a black background without any prompt about the nature of the movement. Adding specific instructions (e.g., "The character that you will see will be dancing") or contextual cues (e.g., background music, situating the PLD into a bar) should reduce these error rates to the minimum in studies where these additional cues would be methodologically acceptable. Animation speed was not associated with difference in identification speed nor accuracy between conditions, meaning that identification and ratings were not driven by other processes such as amount of information available in the moving PLD, but by cues relevant to sexual information processing. The unexpected effect of slower animation speed on ratings of sexualization could be interpreted in the same way: slower dance movement could be perceived as more sensual and be more easily sexualized, which might not be the case for walking. Taken together, these results support using PLD stimuli in future study on sexual objectification.

Our study provided convergent validity for our novel methodology, which also gave some insight into sexual objectification processes. Participants who reported higher positive attitudes towards sexual objectification and those who engaged more frequently in such behaviors rated all the animations as more sexualized, regardless of movement type or manipulation of sexualization. More importantly, no difference was observed between participants based on reported behaviors for the dancing PLDs, only for the walking ones. This means that what really distinguish those who engage in more frequent and/or more serious objectifying behaviors is their sexualization of all movement types, not only those that are already socially or contextually sexualized, like dance (Fink et al., 2015). In other words, our result suggest that sexual objectification is associated with perceiving sexual cues were there are none or few. Evidently, this conclusion should be taken as preliminary until replicated using a more diverse set of movement type.

Our results also converge with existing scientific literature on sexual objectification: higher sexualization ratings were found when participants attributed a female gender to the PLD. More importantly, our sexualization manipulation of the movement animations was more effective when combined with a female gender attribution compared to other genders. These results support the fact that women are more easily sexualized than man. Evidently, due to the way it was measured and not manipulated, this conclusion should be taken as correlational and not experimental. The direction of the relation between sexualization and gender attribution is unclear: 1) perceiving a woman in a moving PLD could lead to higher sexualization ratings, or 2) perceiving a sexualized movement could lead to the conclusion that the PLD is necessarily a woman. Either way, this suggest that the association with "sexual" is stronger for woman than for man. Future research should manipulate the order of the tasks and gender attributed to the PLD to systemically study this association.

Finally, using PLD stimuli is a first step toward the systematic identification of a target's characteristics that can facilitate its sexual objectification by a perceiver. While Bernard et al. (2019) and Bernard and Wollast (2019) propose that objectification is driven by a suggestive posture rather than revealing clothing, we think the stimuli used in these studies are suboptimal to reach such conclusion. If suggestive posture is defined as an "open body language that appears to invite sexual activity" (Bernard et al., 2019), still image might not be the best medium to convey such information. For example, facial expressions are more easily recognized when presented as dynamic stimuli compared to still images (Martinez et al., 2016). Both static and dynamic cues are used to judge the attractiveness of women (Morrison et al., 2018). The dynamic nature of the PLD stimuli is one of their strength: sexual suggestiveness can be captured in simple movement cues. Moreover, these cues can be significantly isolated from other visual or contextual cues using a simple set of 14 moving white spheres placed at the principal body articulations of the human body. With this little information, participants were able to not only detect a movement, but to infer a gender and perceive a sexualized attitude. PLD could be conceived as thin slices of behaviors on which participants inferred information about the underlying character (Ambady, 2010), relaying on intuitive rather than deliberative mode of social information processing. While these heuristics can lead to surprisingly precise judgments (Ambady, 2010), they can also lead to error in inferences that can have important social consequences, such as sexual objectification. This interpretation of the effect is compatible with the cognitive model of sexual objectification (Bernard et al., 2019), where early processes of information processing (visual processing, attention, and memory) are thought to be responsible for the perception of a person as a collection of parts rather than a global physical entity.

Yet, now that the use of PLD as a methodology to manipulate perception of sexualization is validated, it is possible to manipulate other variables susceptible to influence sexual objectification during immersions in virtual reality while having higher control on movement cues. Since these stimuli were created using virtual reality software, manipulating variables could be simply done by adding a skin to the animated skeleton (e.g., changing the gender, skin-to-cloth ratio, body mass index, skin color of the character) or by situating the PLD into different virtual environment. Also, knowing that participants can detect sexualization with movement cues, new animations could be

created to explore the effect of movement in other contexts (e.g., workplace and sexual harassment), in various sound ambiances (e.g., classical vs. electro music), or when exposed to explicit (Baus and Bouchard, 2017) or implicit (Quintana et al., 2019) olfactory cues. The role of presence, embodiment, or egocentric vs. allocentric perspectives could also be explored.

Some limits of this study must be noted. By conducting an anonymous study online, some variables that could affect how the stimuli were processed across participants were not controlled for (e.g., screen size between laptop or mobile devices, environmental context devoid of potential distractors). Replicating this study in a laboratory setup would help standardize stimulus presentation. While a complete randomization presentation order was used between participants, a repeated-measure effect could still have affected their responses by being exposed twice to the same movement (slow and fast speed), and twice to the same category of movement (walking and dancing). Using a between-subject design in the future could help mitigate that effect. Yet, since animation speed was dismissed as a potential confounding factor, future studies could simply compare responses over more categories of movement. Finally, the sexualization manipulation was made with movement more typical of female gender (e.g., movement of the hips while dancing and walking), which could have affected the gender attribution results. It would be interesting to extend our results using sexualized movements that are more typical of men or outside of the heteronormative context to compare its effect on sexual objectification.

CONCLUSION

In this study, we aimed to validate PLD stimuli as a methodology for the systematic study of the variables leading to sexual objectification. Results showed that manipulating the level of sexualization through PLD was effective, with participants being able to correctly identify the nature of the movement presented and rating the sexualization of these movement at the intended level. Doing so, we were able to separate movement from other visual cues to induce perception of sexual suggestiveness as a factor for sexual objectification, marking a steppingstone toward the manipulation of other factors associated with physical appearance.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité d'éthique de la recherche de l'Université du Québec en Outaouais. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

KN, AV, and SB designed the study. KN and AV collected the data. KN analyzed the data. KN, AV, and SB drafted the manuscript. SB facilitated the study execution and aided in interpretation of findings. All authors critically reviewed the draft and made significant contributions to the final version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frvir.2021.623660/full#supplementary-material

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Conflict of Interest: SB is the President of, and own equity in, Cliniques et Développement In Virtuo, a spin-off company from the university that uses VR and distributes virtual environments designed for the treatment of mental disorders. The terms of these arrangements have been reviewed and approved by the Université du Quebec en Outaouais in accordance with its conflict of interest policies.

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