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Avatar characteristics induce users' behavioral conformity with small-to-medium effect sizes: a meta-analysis of the proteus effect

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ABSTRACT

Over a decade of research on *the Proteus effect* in numerous contexts suggests that people conform in behavior and attitudes to their avatars' characteristics. In order to provide clarity about the reliability and size of the Proteus effect, a meta-analysis was conducted with 46 quantitative experimental studies in which avatars with specific characteristics were randomly assigned to participants. Results indicate a relatively consistent effect size (between .22 and .26, depending on subset of studies examined) and nearly all variance explained. Unexplained variance differed between studies that used behavioral or attitudinal measures, while studies which examined potential moderators explained all variance. Overall, this research suggests that the Proteus effect is a reliable phenomenon, with a small-but-approaching-medium effect size according to a traditional rule of thumb, but is relatively large compared to other digital media effects examined in previous meta analyses.

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Avatars – self-representations that facilitate interactions in mediated spaces – are a central element of the media use experience with which many people identify and have meaningful relationships (Banks, 2015; Bessière, Seay, & Kiesler, 2007; Klimmt, Hefner, Vorderer, Roth, & Blake, 2010; Van Looy, Courtois, De Vocht, & De Marez, 2012). Given the important role of avatars in media use, the potential for avatars to influence their users' behaviors and attitudes both in mediated and actual (unmediated) contexts has gained significant attention in media effects scholarship (Yee, Bailenson, Urbanek, Chang, & Merget, 2007). Within this realm of inquiry into the media effects of avatars, one set of studies focuses on *the Proteus effect* – the phenomenon that people conform in behavior and attitudes to their avatars' characteristics. Research on this phenomenon since it was discovered over a decade ago has found that avatar identity characteristics affect numerous outcomes, including negotiation aggressiveness (Yee & Bailenson, 2007; Yee, Bailenson, & Ducheneaut, 2009), dating partner choices (Yee & Bailenson, 2009),

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antisocial behavior (Peña, Hancock, & Merola, 2009; Yoon & Vargas, 2014), food choice (Fox, Bailenson, & Binney, 2009; Sah, Ratan, Sandy Tsai, Peng, & Sarinopoulos, 2016), physical exercise (Li, Lwin, & Jung, 2014; Peña, Khan, & Alexopoulos, 2016; Peña & Kim, 2014), racial bias (Aviles, 2017; Peck, Seinfeld, Aglioti, & Slater, 2013), body dissatisfaction (Fox, Bailenson, & Tricase, 2013; Sylvia, King, & Morse, 2014), financial risk-taking (Hershfield et al., 2011), consumer choices (Ahn & Bailenson, 2011), math performance (Lee, Nass, & Bailenson, 2014; Ratan & Sah, 2015), student engagement (Ratan et al., 2016), and creative thinking (Buisine, Guegan, Barré, Segonds, & Aoussat, 2016; de Rooij, van der Land, & van Erp, 2017; Guegan, Buisine, Mantelet, Maranzana, & Segonds, 2016).

Although the Proteus effect may seem like a valid phenomenon given the broad array of contexts within which it has been tested and supported, these tests have not provided consistent evidence for the effect, with some studies unable to replicate the effect at all (Kaye, Pennington, & McCann, 2018; Sylvia et al., 2014) while others find medium-to-large effects sizes (Banakou, Groten, & Slater, 2013; Guegan et al., 2016). Hence, the present research aims to provide clarity about the reliability and size of the Proteus effect by offering the first meta-analysis of previous research on the phenomenon. This meta-analysis is conducted with the intention of identifying the extent to which the Proteus effect *has occurred* in previous studies as well as the extent to which it *could occur* in future research and interventions. The former intention represents a more traditional approach to meta-analysis which elucidates the extent of a phenomenon, presumably as it exists "in the wild," without deliberate intervention designed to augment or diminish the effect, much like a meta-analysis of how violent video games influence aggression. The latter intention focuses instead on the *potential* for the phenomenon to be harnessed by designers (e.g., of virtual environments) to deliberately influence users' behaviors, presumably by utilizing the mechanisms and contexts that have most strongly facilitated the Proteus effect. In pursuit of these two aims, the meta-analysis reports on different subsets of Proteus effect studies and interprets which study characteristics are likely to contribute most strongly to the Proteus effect.

Typical meta-analytic techniques were followed. A body of studies related to the Proteus effect was identified through a thorough examination of publication outlets and emails to individual authors. The publications which reported quantitative experimental studieswere selected for inclusion in the analysis. The statistics presented from these studies were used to calculate a standard effect size measure for the full set of studies as well as for different subsets depending on study design characteristics. Overall, this research suggests that the Proteus effect is a reliable phenomenon, with a small-but-approaching-medium effect size according to a traditional rule of thumb, but is relatively

large compared to other digital media effects examined in previous meta analyses.

Background

The effects of virtual reality (VR) on human perceptions are well documented (Cummings & Bailenson, 2015) and within such virtual environments, "the avatar is the primary identity cue" (Yee et al., 2007, p. 274). Identity cues provide information about an individual's traits (e.g., demographics, group memberships) that guide behaviors. Earlier work by scholars such as Reeves and Nass (1996) provide extensive theorizing and preliminary research on how identity cues prompted by electronic media can influence social interactions and behavior. Later work on the effects of identity cues focused on the capacity of the medium to convey these cues (Pratt, Fuller, & Northcraft, 2000), the differing number of these cues between computer-mediated and face-to-face communication (Rice & Gattiker, 2001), and how identity cues provide information about communication partners (Ramirez, Walther, Burgoon, & Sunnafrank, 2002).

Approaches such as the Social Presence Theory (Short, Williams, & Christie, 1976), Media Richness Theory (Daft & Lengel, 1986) and the Cluelessness Model (Rutter, 1987; Rutter & Stephenson, 1979) placed emphasis on the ability of a medium to carry identity cues to determine social effects. Later research examined the nature of these cues in the perception of communication partners, and how a lack of these cues caused ambiguity and uncertainty in communication (Kiesler, 1986; Sproull & Kiesler, 1991; Tanis & Postmes, 2003). In a study of virtual dyadic collaboration, subjects were either assigned an avatar of themselves and their partner or worked in the absence of any avatar throughout the experiment (Tanis & Postmes, 2007). Subjects in the former condition were found to have better impressions of their partners which resulted in greater overall performance (Tanis & Postmes, 2007). Identity cues reduce ambiguity in virtual environments and as a result can lead to improved interactions (Sproull & Kiesler, 1991).

Yee and Bailenson (2007) took a step further in their seminal article on the Proteus effect, proposing that identity cues that were prompted through users' avatars can cause behavioral and attitudinal changes. They argued that the appearance of a user's avatar prompts the user to infer expected attitudes and subsequently display behavioral conformity to these attitudes (during and/or after avatar use); a phenomenon they coined the Proteus effect. In other words, they suggested that the Proteus effect phenomenon occurs when users act based on how their avatars look and such behaviors may take place in the virtual environment as well as outside of it. In their study, individuals were assigned avatars of various heights before interacting with confederates. Results showed that participants assigned taller avatars demonstrated smaller social

distances and exhibited greater confidence and intimacy with the confederate and these effects occurred both within the virtual environment and during subsequent face-to-face interactions (Yee & Bailenson, 2007). A later study found that avatar height predicted player performance in an online game (Yee et al., 2009).

Additional studies explored various settings and consequences of the Proteus Effect. In a study on virtual self-endorsement, Ahn and Bailenson (2011) allowed participants to see themselves endorsing various products in VR. Those who engaged in self-endorsement reported higher brand attitudes, purchase intention and brand preference compared to those in the other-endorsement condition. Aymerich-Franch, Kizilcec, and Bailenson (2014) found that participants assigned to avatars that looked similar to themselves showed greater anxiety in a VR public speaking task as compared to those assigned to dissimilar avatars.

Theoretical foundations

The Proteus Effect is rooted in self-perception theory, which proposes that people infer their attitudes and beliefs from observing themselves as if from a third party (Bem, 1972). Contrary to popular belief that attitudes precede behavior, Bem (1972) suggested that people develop their attitudes by observing their own behaviors and then inferring what attitudes may have caused them. Valins (1966) assigned participants to view photographs of people and told them later that their heart rate had increased during the viewing session. These participants subsequently rated the people in these photographs as more attractive. The explanation was that participants had assumed that the increase in their heart rate was due to an increased emotional arousal. As a result, they then judged the accompanying photographs as being more attractive.

Yee and Bailenson (2007) further inferred that the effects of self-perception are enhanced in virtual environments due to the occurrence of deindividuation. In virtual settings, individuals tend to be less fixated on their selves and feel a greater sense of anonymity. Consequently, they focus their attention on a variety of external cues. With regard to the Proteus Effect, this might manifest in the form of identity cues, such as an avatar's appearance (e.g., height, skin color, similarity to self). The salience of these cues as prompted by the avatar's appearance leads to attitudinal and behavioral changes through self-perception.

Peña et al. (2009) offered an alternative explanation for the Proteus Effect. They suggested that the situational cues on which individuals focus in virtual environments prime them to think and act in certain ways, due toassociations with an individual's memories or common stereotypes associated with these cues. According to the automaticity model, individuals are primed to engage in cognitive or behavioral responses based on their perception of

these associations, often without consciousness of or intention to engage in them (Bargh, 2006). In the first of two experiments, they found that participants who used avatars dressed in black exhibited more aggression compared to those who used avatars dressed in white. In the second experiment, participants whose avatar was dressed in KKK attire wrote more aggressively themed stories compared to those dressed as a doctor.

In response to Peña et al.'s (2009) study, Yee and Bailenson (2009) asserted that there are conceptual differences between priming and self-perception. The former suggests that an individual is observing an external party, focusing on external cues, associating them with stereotypes, and being influenced by them. The latter involves the individual acknowledging the avatar as a manifestation of the self in the virtual environment, thereby influencing the perception of the self to align with the avatar's characteristics, resulting in a greater impact on attitudes and behavior than that which comes through priming alone. The results of their experiments (Yee & Bailenson, 2009) provided evidence for the propositions, showing that virtual embodiment caused larger behavioral changes compared to observing an external party.

However, Ratan and colleagues have argued for a theoretical approach to the Proteus effect that takes into account both self-perception and schema activation (Ratan & Dawson, 2016; Ratan & Sah, 2015). They assert that using an avatar causes an association between the user's perception of self and the avatar's characteristics (Chandler, Konrath, & Schwarz, 2009; Klimmt et al., 2010). In other words, as an individual uses an avatar, the schema of concepts that are related to the self becomes more closely connected to the schema of concepts that are related to the avatar. Hence, when one of these schema is activated, the other schema is more likely to be activated as well. In the context of the Proteus effect, when someone must perform a task during or after avatar use, they will engage in a process of self-perception in order to determine how they should act. The more the schema of self-related concepts activated during this process is associated with the schema of avatar-related concepts, the greater the likelihood of conformity to the avatar's characteristics.

This explanation draws from both self-perception and schema activation perspectives and serves as the basis for the argument that Proteus effect outcomes should be stronger the closer the user feels to the avatar (as reflected by identification, embodiment, self-presence, etc.). Supporting this argument, one study found that participants who used a gender-consistent (compared to gender-swapped) avatar experienced a greater emotional connection to the avatar during use, as reflected by stronger physiological responses to observing the avatar receive negative treatment after use (Ratan & Dawson, 2016). Another study found that participants who customized their avatars (compared to those who used generic avatars) were more

likely to be influenced by the avatar's gender during a subsequent math task (Ratan & Sah, 2015).

Overall, these facets of user-avatar closeness (i.e., gender consistency, emotional connection, and customization) were associated with stronger Proteus effects, supporting the argument that the phenomenon is facilitated by a process of both self-perception and schema activation. This argument also supports the claim that studies may fail to replicate the Proteus effect if they do not sufficiently compel the avatar user to associate self-related and avatar-related schema (i.e., through embodiment, customization, or other contributors to associating the avatar and self).

Examining the strength of the proteus effect

Technological advancements have led to an increase in the quality of the virtual experience at a fraction of the costs observed in the past decade (Fox et al., 2013). There is a great proliferation of consumer-level head-mounted displays and VR systems, resulting in more individuals being able to experience virtual environments from the comfort of their homes. With more people placing themselves in virtual environments and existing as avatars not only for entertainment, but also for education and health, it is important to understand the potential effects of digital embodiment. To what extent do and can our avatars affect us? These are important questions, as with all media effects, because of the potential for outcomes that are positive (e.g., healthy, educational, prosocial) or negative (e.g., destructive, aggressive, antisocial). Further, as described earlier, although the Proteus effect has been replicated within a wide range of contexts and outcomes, the strength of these findings is inconsistent, with some studies yielding null or small findings while others exhibit medium-to-large effects sizes. Hence, this study pursues *this general research question: how consistent and powerful is the Proteus effect?*

Further, this study aims to identify ways in which the Proteus effect can be induced most effectively. For example, the strength of the effect might differ depending on the specific type of avatar characteristics, avatar use constraints (e.g., amount of user control, user customization), or types of outcomes (e.g., during or after avatar use). To this end, insofar as it is possible within the framing of the first research question, this study pursues *this secondary research question: which study characteristics have contributed most strongly to the Proteus effect and what does this imply about the mechanisms of the phenomenon?*

Methods

To answer these questions, a meta-analysis was conducted to quantify the influence of the Proteus Effect across previous studies. Meta-analysis is an appropriate method for aggregating data – including even small or

nonsignificant results – from multiple studies to elucidate the general trends and potential mediator and moderator variables (Hunter, Schmidt, & Jackson, 1986; Preiss & Allen, 1995; Rosenthal & DiMatteo, 2001). Generally established meta-analytic procedures were followed, as described below.

Study selection and inclusion criteria

We began the study-selection process by searching bibliographic indices for "proteus effect" on the following academic databases: EBSCOhost, Proquest (all databases), Microsoft academic, PsycINFO, PsycArticles, ScienceDirect, ISI Web of Knowledge, and Research Gate. We also conducted this search with Google Scholar, but it yielded over 900 results, many of which were largely irrelevant (e.g., from the molecular biological sciences), so we only used Google Scholar to search for articles with which we were already familiar through other sources that did not show up in the initial searches.

For the next step of our search, in order to account for publication bias, we emailed first authors of all the Proteus effect studies identified, asking if they had any additional unpublished (or not-yet published) research on this topic. Specifically, we requested "experimental research on the Proteus effect – in which avatar characteristics were manipulated as a means of behavioral influence – that has not been published in an academic journal," including any with, " … results with effect sizes that were too small for publication." Of the 28 emails sent, we received 10 replies, resulting in four additional papers in our set.

Throughout this study selection process, we collected only articles that were relevant to the Proteus effect in the context of media use. The term "proteus effect" has also been used in other fields unrelated to media (e.g., stem-cell research) and such papers were not collected. We also searched for articles that included an effect of avatar identity that did not necessarily use the term "proteus effect", and some of the researchers who replied to our email request suggested such articles. Overall, this study selection process identified 83 studies for potential inclusion in the meta-analysis.

Next, we filtered out studies according to our inclusion criteria. We included only quantitative experimental studies in which avatars with specific characteristics were randomly assigned to participants. This type of study allows researchers to test whether differences in avatar characteristics *cause* differences in user outcomes. While some non-experimental studies (e.g., surveys) have addressed the Proteus effect (Hooi & Cho, 2013; Yee, Ducheneaut, Yao, & Nelson, 2011), there are other possible explanations for relationships found. For example, avatar selection and user behavior might be independently influenced by third variables, such as behavioral intent.

A total of 36 studies were eliminated because they did not include an experimental manipulation of distinct avatar characteristics. One study was

removed because no statistical information was provided and the authors could not be contacted (Obana, Hasegawa, & Sakuta, 2017). Another study was removed because the theoretical connection between the avatar manipulation (playing as a scientist, warrior or neutral character) and the measured behavior (picking up in-game items) was unclear (Siebelink, van der Putten, & Kaptein, 2016). Another study was removed because the avatars in the experiment were not designed to represent the participant, but instead a salesperson (Peña & Yoo, 2014). Another study was removed because the dependent variable reported was a writing task about the avatar, illustrating differences in avatar perception but not in changes in self-perception or subsequent behavior (Peña, McGlone, & Sanchez, 2012). Thus, there were a total of 46 studies included in the analysis.

Note that most, but not all, of the studies included in the dataset were intended to test the Proteus effect explicitly. Some studies included in the dataset were not explicitly designed to test the Proteus effect but did experimentally manipulate avatar characteristics in order to determine whether participants conformed to behaviors associated with those avatar characteristics, which still aligns with the definition of the Proteus effect. For example, in Banakou, Kishore, and Slater (2018), participants who embodied an intelligence-associated avatar (i.e., it looked like Albert Einstein) performed better on a cognitive puzzle-solving task compared to participants who embodied a generic avatar. This study was not explicitly framed as a test of the Proteus effect, but it clearly falls within the paradigm. Although the authors of such studies may not have originally intended to test the Proteus effect, their findings still reflect the phenomenon and thus we included such studies in our analysis.

Next, we developed a database of the studies included in the set along with their reported statistics. If an article contained multiple studies, each study was recorded individually for the final calculations. Some studies reported tests for both main effects (of avatar type as the independent variable) and interaction effects (with a second independent variable as a moderator, such as whether participants controlled and/or customized their avatars). In order to avoid double counting, the statistics from only one of the tests was used to calculate one weighted r per study. Main effects were prioritized because they offer more consistent interpretation across studies – given that the types of variables tested in the interaction effects differed between studies – and such consistency in comparison is a fundamental goal of meta-analysis. However, some studies did not report the findings from their tests of main effects, but they did report statistics for their interaction effects. In an effort to be both as inclusive as possible while also transparent about consistency within the dataset, we retained such studies and used their interaction effect statistics (e.g., F score) to calculate weighted r values, but we also present the results both with and without such studies to allow for a range of interpretations.

The results of the fully combined dataset should be treated with caution because main and interaction effects represent different theoretical concepts. Here, main effects represent the influence of a single avatar characteristic on the user, while interaction effects represent the influence of an avatar characteristic being moderated by another variable of interest (e.g., avatar customization or participant control). Given this concern, the results are presented both with and without these interaction-effect studies. Among the final sample of 46 studies, 37 reported main effects, while 9 reported interaction effects only.

Next, because some studies included multiple dependent variables, we only counted one test statistic per individual study. If a study reported both a behavioral and an attitudinal measure, only the behavioral measure was included in the analysis. Behavioral effects were prioritized in this research because they are ostensibly more valid reflections of the potential of the Proteus effect to influence individuals than self-reported measures. Part of this reasoning stems from the theoretical foundation of the Proteus Effect being situated in self-perception theory, which proposes that individuals assume their attitudes by observing their behaviors (Bem, 1972). Further, as the Theory of Planned Behavior suggests (Ajzen, 1991), behaviors are determined by multiple contributors in addition to attitudes (e.g., self-efficacy), and so media factors (such as avatars) are generally less capable of affecting behaviors than attitudes. Thus, by setting a preference for behavioral measures, our assessment of the Proteus effect is more conservative than if we had focused solely on attitudinal measures. That said, this choice represents a potential limitation of the present research and we address this in the Discussion section. Further, in order to be as inclusive as well as transparent as possible, studies that reported only attitudinal effects were still included in the dataset. The analysis is presented with and without these studies in order to facilitate a range of interpretation. Among the final sample of 46 studies, 29 included behavioral effects and 17 examined attitudinal effects only.

Next, we identified that out of the 46 studies in our dataset, 43 were between-subjects designs and three were within-subjects designs. We considered weighting these studies more heavily in our analysis (e.g., multiplying *N* by the number of within-subjects conditions) given that within-subjects studies tend to include fewer participants than between-subjects studies, but we were also concerned about common threats to the validity of within-subjects studies that might have diminished their relative effect sizes, such as participant awareness of the study intent leading to demand characteristics (Charness, Gneezy, & Kuhn, 2012; Greenwald, 1976). We worried that such issues might be particularly problematic for Proteus effect studies given that the mechanism of the phenomenon relates to self-perception, which is an extremely salient contributor to behavior (Wheeler, Demarree, & Petty,

2007). In other words, the association between an avatar's characteristics (e.g., short height) and a user's self-perception likely decays slowly, meaning that associations with subsequent avatar characteristics (e.g., tall height) are likely inhibited unless there is a sufficiently large amount of time between inductions. Hence, determining the appropriate additional weighting for the within-subjects studies would be difficult and somewhat arbitrary without a larger comparison of between- and within-subjects studies in this domain. The three within-subjects studies in this dataset do not form a sufficient basis on which to make such comparative generalizations. Thus, following our aforementioned goal to be as inclusive as possible while also promoting transparency and facilitating a range of interpretations, we conducted one analysis including the three within-subjects studies (as is, without any special weighting) within the whole dataset and also one analysis with between-subjects studies only. This approach may have led to an undervaluation of the effect of within-subjects studies on the calculated effect size across the whole dataset, but by comparing this to an analysis of only the between-subjects studies, we can infer the extent of this potential undervaluation (note: it is small, a difference of $r < .01$).

For all studies in the set, we were able to collect sample sizes, degrees of freedom, and the reported test statistics (r, t values, or F values). Among the final sample of studies, participant sample size ranged from 12 to 298, with a mean of 84.07. For studies that did not report an r value, we calculated an r value using reported t or F values, following a standard formula (Rosenthal & DiMatteo, 2001). See Table 1 for a summary of the studies included.

In order to address our secondary research question (Which study characteristics have contributed most strongly to the Proteus effect?), we also coded each study for the specific type of avatar characteristic that was manipulated, the specific type of outcome measure, and whether this outcome was measured during or after avatar use.

We also collected demographic information on study participants when reported. Out of the 46 studies, 27 reported participant age (M = 20.81, SD = 2.33). All but one study reported either participant sex or gender, with 38.88% reported as women or female and 61.12% as men or male. Finally, 12 studies reported participant race, with 68.16% reported as white and 31.84% as non-white.

Results

We conducted a meta-analysis following generally established procedures (Rosenthal & DiMatteo, 2001). First, we calculated the weighted r values for each study based on the study sample size. Then, for each set or subset of

Table 1. Overview of studies included in the present analysis.

Study	Effect Size (r)	*N*	Effect Type	Measure Type	Between- or Within-subjects
(Ash, 2016)	0.16	80	Interaction	Behavioral	Between
(Aviles, 2017)	0.15	236	Main	Attitudinal	Between
(Aymerich-Franch et al., 2014)	0.3	54	Main	Attitudinal	Between
(Banakou et al., 2013)	0.53	29	Main	Attitudinal	Within
(Banakou, Hanumanthu, & Slater, 2016)	0.37	59	Main	Attitudinal	Between
(Banakou et al., 2018)	0.37	15	Main	Behavioral	Between
(Bian, Zhou, Tian, Wang, & Gao, 2015) [Study 1]	0.36	90	Main	Attitudinal	Between
(Bian et al., 2015) [Study 2]	0.18	90	Main	Attitudinal	Between
(Buisine et al., 2016)	0.76	12	Main	Behavioral	Between
(Chen, Schweisberger, & Gilmore, 2012)	0.45	30	Main	Attitudinal	Between
(Christou & Michael, 2014)	0.32	48	Main	Behavioral	Within
(Fox et al., 2013)	0.28	86	Main	Attitudinal	Between
(Fox & Bailenson, 2009) [Study 1]	0.39	63	Main	Behavioral	Between
(Fox & Bailenson, 2009) [Study 3]	0.22	73	Main	Attitudinal	Between
(Fox et al., 2009)	0.29	69	Interaction	Behavioral	Between
(Gomes, 2013)	0.1	145	Main	Attitudinal	Between
(Guegan et al., 2016)	0.41	54	Main	Behavioral	Between
(Hershfield et al., 2011) [Study 1]	0.26	50	Main	Attitudinal	Between
(Hershfield et al., 2011) [Study 2]	0.42	21	Main	Attitudinal	Between
(Kaye et al., 2018)	0.02	120	Main	Behavioral	Between
(Kilteni, Bergstrom, & Slater, 2013)	0.41	36	Main	Behavioral	Between
(Lee et al., 2014)	0.2	120	Interaction	Behavioral	Between
(Lee-Won, Tang, & Kibbe, 2017)	0.2	238	Main	Behavioral	Between
(Li et al., 2014)	0.22	140	Main	Behavioral	Between
(McCain, Ahn, & Campbell, 2018)	0.21	131	Main	Attitudinal	Between
(Palomares & Lee, 2009)	0.16	151	Interaction	Behavioral	Between
(Peck et al., 2013)	0.39	30	Main	Behavioral	Between
(Peña et al., 2009) [Study 1]	0.51	51	Main	Attitudinal	Between
(Peña et al., 2009) [Study 2]	0.25	78	Main	Attitudinal	Between
(Peña et al., 2016)	0.3	96	Main	Behavioral	Between
(Peña & Kim, 2014)	0.21	94	Main	Behavioral	Between
(Ratan & Dawson, 2016)	0.44	76	Main	Attitudinal	Between
(Ratan & Sah, 2015)	0.42	64	Interaction	Attitudinal	Between
(Ratan et al., 2016)	0.11	298	Main	Behavioral	Within
(de Rooij et al., 2017)	0.32	61	Main	Attitudinal	Between
(Sah et al., 2016)	0.21	87	Interaction	Behavioral	Between
(Sherrick, Hoewe, & Waddell, 2014)	0.15	142	Main	Behavioral	Between
(Sylvia et al., 2014)	0.02	47	Main	Attitudinal	Between
(Van Der Heide, Schumaker, Peterson, & Jones, 2012)	0.35	48	Main	Behavioral	Between
(Via, 2016)	0.13	85	Interaction	Behavioral	Between
(Yee, 2007)	0.23	57	Main	Behavioral	Between
(Yee & Bailenson, 2007) [Study 1]	0.4	32	Main	Behavioral	Between
(Yee & Bailenson, 2007) [Study 2]	0.33	48	Main	Behavioral	Between
(Yee & Bailenson, 2009)	0.27	70	Interaction	Behavioral	Between
(Yee et al., 2009)	0.33	40	Interaction	Behavioral	Between
(Yoon & Vargas, 2014)	0.53	123	Main	Behavioral	Between

studies, we used these valued to calculate the average weighted *r*, 95% confidence intervals for *r*, variance, expected variance due to sampling error, and unexplained variance (see Table 2).

Table 2. Summary of meta-analysis results for all studies and study subgroups.

Study (Sub)Set	*K*	*N*	r (weighted)	95% CI, Lower	95% CI, Upper	Variance	Expected Variance	Unexplained Variance
All Studies	46	3867	0.24	0.210	0.273	0.019	0.010	0.009
Studies Reporting Main Effects	37	3101	0.25	0.212	0.282	0.022	0.010	0.012
Studies Reporting Interaction Effects Only	9	766	0.22	0.151	0.293	0.007	0.011	−0.003
Studies Reporting Behavioral Measures	27	2396	0.23	0.192	0.272	0.019	0.010	0.010
Studies Reporting Attitudinal Measures Only	19	1471	0.26	0.207	0.310	0.018	0.011	0.005

Research aim 1: consistency and power

We began to address our first research question (how consistent and powerful is the Proteus effect?) by analyzing the data across all studies included in our sample. For these 46 selected studies, weighted *r* was .24 and variance was .019. Expected variance due to sampling error was .01, yielding unexplained variance of .009 (expected variance subtracted from observed variance).

We next examined subsets of the studies in our sample based on the study design and variables reported. In the subset of studies reporting main effects (k = 37), weighted *r* was .25 and unexplained variance was .012. In studies reporting interaction effects only (k = 9), weighted *r* was .22 and all expected variance was explained, though we should note the small sample size of 9 studies as a caveat. In the subset of studies reporting behavioral effects (k = 27), weighted *r* was .23 and unexplained variance was .009. Finally, in the studies reporting attitudinal effects only (k = 19), weighted *r* was .26 and unexplained variance was positive but small (.007).

Next, we conducted these same analyses for all subsets of the data, but with the within-subjects studies removed from the samples. Across the largest subset of remaining studies (k = 43), weighted *r* was .25 (an increase of less than .008 from the larger sample), variance was .017 (a decrease of .001), expected variance due to sampling error was 0.0104 (an increase of .0003), yielding unexplained variance of .007 (a decrease of .0019). Across all other subsets analyzed, changes were similarly small, with the weighted *r* increasing (never decreasing) at most by .015 (for the studies with behavioral measures) and unexplained variance decreasing in all cases of change. We took these diminutive changes as evidence that the inclusion/removal of the within-subjects studies did not make a meaningful difference in the present analysis, which makes sense given that there were only four such studies. Thus, we included these studies in all of the subsequent analyses.

Next, we examined the confidence intervals (CIs) across the different subsets analyzed. We noted that the CIs for these subsets overlap with each other. This indicates that although the *r* values found differed between subsets, these differences were not significant. Thus, addressing our primary research question (How consistent and powerful is the Proteus effect?), the effect sizes found across the different study subsets were relatively consistent (between .22 and .26). This suggests that the Proteus effect is reliable and has a small-but-approaching-medium effect size according Cohen's rule of thumb (Cohen, 1992). Further, unexplained variance across studies was low, suggesting that the differences in the outcomes measured in these studies resulted mostly from the experimental manipulations.

Research aim 2: inferences about mechanisms

Next, attempting to address our secondary research question (Which study characteristics have contributed most strongly to the Proteus effect and what this implies about the mechanisms of the phenomenon?), we examined the specific information collected about the studies' manipulations and outcomes for trends. We found a wide range of applications of the effect with few replications of study manipulations or outcomes. For example, one of the most common categories of avatar-characteristic manipulations, avatar gender, was only included in six studies, while avatar race and attractiveness were only included in three and four studies, respectively. All other avatar characteristic manipulations were less frequent. These limited sample sizes would likely not allow for reliable generalization. Still, in the case of avatar gender, we examined the weighted r values and noted that three of them were above the whole-sample mean and three were below. Thus, we have no reason to believe that manipulations of avatar gender are any more or less effective at inducing the Proteus effect than other avatar-characteristic manipulations.

Regarding outcomes, the dataset contained similar heterogeneity, with the most frequent outcomes still only represented in a small number of studies (e.g., racial bias, aggression and creativity in four or fewer studies). We also hoped to examine the extent of the Proteus effect in studies which measured the phenomenon behaviorally after avatar use compared to behaviorally during use in order to ascertain the extent to which the effect persists over time. Unfortunately, only five of the studies included behavioral measures after avatar use, so again, this comparison would not have been reliable.

However, one category of studies in the sample does permit inferences about moderating effects: studies that reported only interaction effects, which reflected the highest weighted r across all study subsets and was the only subset in which all variance was explained. Keeping in mind that there were only nine studies in this subset and the weighted r was still within the range of the other subsets, we might take this as qualitative evidence of the potential that these

studies identified successful moderators of the effect. Indeed, in all but one of these studies, the moderating variable was a characteristic related to user-avatar closeness (e.g., user control, avatar customization, user gender, user race). For example, studies have found that Proteus effect outcomes are stronger when participants control an avatar compared to simply watching an avatar perform (Yee & Bailenson, 2009; Yoon & Vargas, 2014). Although this is not resounding evidence, this finding aligns with the argument that the Proteus effect is augmented when users associate self-related and avatar-related schema (Ratan & Dawson, 2016; Ratan & Sah, 2015), which may occur through embodiment, customization, or other factors that contribute to the association between the avatar and the self.

Assessing publication bias

Finally, we calculated the correlation between sample size and weighted r in order assess potential publication bias, given that published studies tend to report only significant effects and higher sample sizes increase the likelihood of such significant findings (Levine, Asada, & Carpenter, 2009). Study sample size and weighted r were found to be negatively correlated ($r = -.56$, $p < .001$), indicating a potential publication bias. Thus, we conducted further analyses of potential publication bias, starting with an analysis of Orwin's fail-safe N (Borenstein, 2005). Using an r of .24 (as observed across the full dataset of 46 studies) and assuming a mean correlation of .00 for all missing studies, our analysis indicated that the observed r for our sample would drop to .20 if there were 10 missing studies and would drop to .15 if there were 31 missing studies. To corroborate this approach, we conducted a trim-and-fill analysis (Carpenter, 2012; Duval & Tweedie, 2000) which led to 19 studies trimmed, resulting in an r of .18. These findings should be interpreted with the caveat that the number of missing studies is calculated based on an assumption that small sample studies are biased toward larger effect sizes, but it is also possible that the smaller studies truly do have larger effect sizes due to differences in participant sampling and protocols (Borenstein, 2005). This seems possible for Proteus effect studies given that many rely on expensive VR equipment and complicated experimental setups, which may lead to strong outcomes but limit sample sizes. Together, these analyses suggest that while there is a potential for publication bias, this bias would need to be quite significant (i.e., over 20 missing studies all with very low effect sizes) in order to suggest that the effect size of the Proteus effect is negligible.

Discussion

This research presents a meta-analysis of the Proteus effect, the phenomenon in which people tend to emulate the behaviors and attitudes that they associate with their avatars' identity characteristics. Data were analyzed from 46 quantitative experimental studies of the Proteus effect in which avatars with specific characteristics were randomly assigned to participants. Although the studies in this dataset offered a wide range of effect sizes, with weighted *r*'s from .02 to .76, results of the meta-analysis suggest that the Proteus effect is reliable, with an average effect size between .22 and .26 (depending on which study designs are being considered) and nearly all variance explained. Subsets of studies were examined in order to account for potential moderators, but confidence intervals overlapped for all subsets, indicating a lack of significant differences between these groups. Still, studies that reported only interaction effects reflected the highest weighted *r* values and most explained variance across all study subsets, potentially offering qualitative evidence that certain moderators that increase user-avatar closeness (e.g., user control, avatar customization) augment the Proteus effect. This implication would be consistent with the argument that the phenomenon results from a process of both self-perception and schema activation (Ratan & Dawson, 2016; Ratan & Sah, 2015), but more Proteus effect studies and meta-analyses will be required to corroborate this claim. Still, overall, this study's results suggest that the Proteus effect is reliable and exists with a small-but-approaching-medium effect size, according to Cohen's rule of thumb (Cohen, 1992).

Comparison to previous media effects meta-analysis

In order to contextualize our findings within the specific field of study, we evaluated the results of previous meta-analyses of related media effects. Research focused on the aggressive outcomes of media use find a range of effect sizes. Ferguson (2015) found weighted *r*'s that ranged from .06, for controlled effect sizes (K = 66), to .14 for bivariate effect sizes (K = 68). Slightly higher effect sizes related to aggressive outcomes have been found, from *r* of .15 (Sherry, 2001), topping off at weighted *r*'s of .18 (K = 140) (Anderson et al., 2010), and .19 (K = 43) (Greitemeyer & Mügge, 2014).

Research on the prosocial outcomes of media use has found a similar range of effect sizes. When looking at prosocial effects of media, Ferguson (2015) found weighted *r*'s that ranged from .06 for studies with controlled effect (K = 51) and .14, for studies with bivariate effects (K = 68). Anderson et al. (2010) found similar results across studies, showing a weighted *r* of .13 for the effects of video games on prosocial behaviors (K = 62). When looking at the prosocial results of media usage, Greitemeyer and Mügge (2014) meta-

analysis divided studies into those that looked at video games with violent outcomes and those with prosocial outcomes. The meta-analysis found a weighted *r* of −.11 for those studies that examined games with violent outcomes (K = 12), and a weighted r = .20 for the studies of games with prosocial outcomes (K = 6).

Another relevant meta-analysis looked at the extent to which perceiving a mediated character as an avatar (presumably controlled by another human) or agent (presumably controlled by a computer program) affects that mediated character's social influence on the user. Fox et al. (2014) found that avatars are more influential, with an unweighted, zero-coded *r* of .22 (K = 119) for avatars.

Results from the present study regarding the effect size of the Proteus effect are generally consistent with the results of these previous media effect meta-analysis, albeit on the higher end. Our initial results found a weighted *r* of .24. When compared to previous meta-analyses that looked at prosocial or anti-social effects of video games, the highest result found, *r* = .20 (Greitemeyer & Mügge, 2014), falls outside of our confidence interval, suggesting a potential significant difference between these results. The related meta-analysis that falls within our confidence interval, *r* = .22 (Fox et al., 2014), examined the difference between the effects of an avatar controlled by a user and those of a more traditional media agent, which is not controlled by a user, such as a non-playable character in a digital game. As the Proteus effect looks at the influence an avatar has on its user, it is possible that this previous meta-analysis is tapping into a similar phenomenon as the Proteus effect.

The results of this meta-analysis, when compared to these previous media effect studies, may suggest that the Proteus effect should be considered one of the stronger media effects phenomena. If this is so, then an avatar, standing as an extension or representation of its user's self, which serves as the foundation of the Proteus effect, is a vitally important variable that should be considered in future media effects studies. With an increasing number of individuals plugging into VR from the comfort of their homes and embodying avatars in virtual environments, the strong influence of the Proteus Effect suggests that researchers cannot ignore the possible impact of avatars on people's attitudinal and behavioral outcomes.

Of particular interest is the difference between results found in the current meta-analysis and those found in meta-analyses that looked at the connection between aggression and violent video games. As mentioned above, the Proteus effect appears to be stronger than effects found in studies that looked at aggressive outcomes of violent video games (Anderson et al., 2010; Greitemeyer & Mügge, 2014; Sherry, 2001), possibly because the psychological mechanisms of the Proteus effect are stronger than the mechanisms addressed by traditional video game effects research. Namely, the Proteus effect is based on the psychological relationship between the user's schema of

self and the schema associated with the avatar. Future research that examines such dynamics between user-avatar relationships and the media environment (e.g., violent video games) may help to provide new insights into why violent video games do not appear to have strong or lasting effects on aggressive behavior.

Our meta-analysis results may also lend credence to the hybrid self-perception/schema activation explanation of the Proteus effect (Ratan & Dawson, 2016; Ratan & Sah, 2015). The subset of studies that reported interaction effects was the only subset that accounted for all variance. This suggests that studies which examine interaction effects are more consistent with each other in their effect size. In other words, the Proteus effect is more reliable when you take factors of avatar use (e.g., embodiment, identification) into account. While there are only nine studies in this subset, which might limit the variance found between studies, the expected variance calculation took this into account. However, this small sample of studies may not adequately represent a larger population of Proteus effect studies that include interaction effects. Presumably, this population of studies does not yet exist. Thus, as future research on the Proteus effect is conducted, researchers should examine interaction effects, particularly focusing on manipulating embodiment in or identification with the avatar, in order to determine whether or not the self-perception/schema activation approach accurately explains the Proteus effect. Further, once the body of Proteus studies is larger, future meta-analyses of this phenomenon may find narrower confidence intervals and thus be able to better differentiate subsets of studies (i.e., potential moderators).

Limitations

Although low, we are still concerned about the unexplained variance in this meta-analysis. We calculated the expected variance, due to sampling error, among the studies to be .01. In our initial meta-analysis calculations, including all of the relevant studies, we found a variance of .019, resulting in an unexplained variance of .009. While certain subsets of studies included in our dataset had low unexplained variance, variance was only fully explained in one subset of studies, those which examined interaction effects (See Table 1). In other words, studies which examine potential moderating variables yielded the most accurate effect size.

Further, unexplained variance was higher for studies that used behavioral measures than those that used attitudinal measures. This may be driven by the greater heterogeneity in the behavioral measures. While attitudinal measures were relatively similar, all consisting of questionnaires that measured attitudes and produced a reliability score, behavioral measures varied widely between studies, ranging from physical distance between two avatars to the number of ideas individuals generated during a brainstorming exercise, and

often were not corroborated with multiple measurements for reliability. These widely differing behavioral measures, in combination with the relatively low number of available studies, may have resulted in the additional unexplained variance. This also reflects the general limitation of the present research that by focusing on behavioral measures (in studies that examined both attitudinal and behavioral outcomes), the full dataset includes a mixture of measure types that are less coherent than if we had focused on attitudinal measures alone. We made this choice to focus behavioral measures given that the Proteus effect was originally conceived of as a phenomenon of behavioral influence and further because behaviors are arguably more difficult to influence than attitudes alone (Ajzen, 1991). Hence, we believe that this approach was conservative relative to the alternative – focusing on attitudinal measures alone – which would have likely led to a higher inferred effect size across the full dataset.

Another limitation is the potential for publication bias in Proteus effect research. Although sample size and *r* are often negatively related in meta-analysis, the negative correlation found between study size and effect size within the research suggest the possibility of publication bias (Levine et al., 2009). Our follow-up analyses suggested that the publication bias would need to be quite significant, with over 20 missing studies, to call into question whether the Proteus effect has a truly meaningful effect size. Considering that our sample included 46 studies, it seems unlikely that nearly one third of all Proteus effect studies are unpublished. In fact, we would expect a relatively low non-publication rate for studies on the Proteus effect because it is a newer phenomenon that has attracted attention mostly from junior scholars. Compared to senior scholars who might experience less pressure to publish and thus would be more comfortable leaving a study in the "file drawer", such junior scholars tend to need to publish as much as possible and thus would be more likely to pursue publication for studies that have negligible findings. Given these caveats as well as the assertion that the most effective approach to addressing possible publication bias in a meta-analysis is to contact researchers in the field and request unpublished studies (Carpenter, 2012), which we did, we are confident that our results reliably reflect the strength of the Proteus effect.

We should also note that in accordance with our inclusion criteria, non-experimental studies were excluded from our analysis, including some studies written by the original research team to study the Proteus effect. For example, studies in which avatar data was scraped from online games and compared to player behaviors (Yee et al., 2009, 2011; Zhang, Dang, Brown, & Chen, 2017) were not included because the avatars were not randomly assigned to participants and thus the directionality of causal influence could not be determined. In other words, although these studies could potentially support the notion that the avatar characteristics cause users to behave in certain ways, it is also

possible that individuals with certain behavioral habits tend to choose avatars with matching characteristics. While the exclusion of such studies is not a limitation to the validity of the present research, it does highlight the limited applicability of the present research to only those studies in which avatar-to-user causality can be established. In other words, not all studies that claim to examine the Proteus effect were included in the present meta-analysis.

Another consideration worth noting is the population within which the phenomenon has been examined. Namely, as with much research in the field of media psychology, most participants were in the college-age range (mean age = 20.81, *SD* = 2.33). This is a potential issue given that the Proteus effect is a phenomenon of behavioral influence through social characteristics and susceptibility to social influence declines precipitously immediately after early adulthood (Krosnick & Alwin, 1989). Thus, there is a chance that for people aged beyond early adulthood, the phenomenon is weaker than this meta-analysis indicates. Further, the sampling of participants in Proteus effects research is skewed toward males or men (61.12%), thus hindering the generalizability of these findings to women or female participants. Namely, just as with age, research suggests that susceptibility to social influence may differ by gender (Aral & Walker, 2012; Whittaker, 1965), especially as related to technology use (Venkatesh & Morris, 2000). Finally, regarding race, and noting that only a minority of studies reported this data (*K* = 12), the breakdown of white (68%) and non-white (32%) participants was also unbalanced. This is not surprising given that the majority of studies were conducted at US-based research universities which likely have majority-white student populations. Although some studies have examined differences in the Proteus effect based on race and ethnicity (e.g., Lee & Nass, 2012; Lee et al., 2014; Peck et al., 2013), most studies included in this meta-analysis did not consider these characteristics. This is an especially important topic because the phenomenon is driven by mindless associations with identity characteristics (i.e., stereotypes), which may differ based on the avatar-user's cultural (e.g., ethnic) background and is potentially related to race. Overall, future Proteus effect research should consider participant race as related to cultural stereotypes and attempt to extend into older and more gender-balanced populations in order to test whether the phenomenon is generalizable beyond the college-age, male- and white-skewed samples in this body of research thus far.

Conclusion

The current meta-analysis suggests that avatars have a meaningful effect on the behaviors and attitudes of their users. The Proteus effect is an important element of media effects research and deserves continued examination. Experimental research on the Proteus effect within the literature which this

study drew upon represents a relatively small number of studies (K = 49) when compared to other media effect meta-analyses. Our understanding of the effects of avatar use will grow with further experimental research on the Proteus effect.

Disclosure statement

No potential conflict of interest was reported by the authors.

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