iDisorders: Psychiatry, Technology, and the Human Social Brain

by

Pei Tin (Nancy) Yang

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Abstract

What impacts does human psychological variation have on usage of evolutionarily-novel, online technological platforms? Autism spectrum disorder and psychotic-affective spectrum disorders, such as positive schizotypy, represents two suites of neurodevelopmental disorders that can be conceptualized as opposite, diametrical ends on a single continuum of socio-cognitive development, with autism characterized by hypo-development in social (i.e., mentalistic) domains and hyper-development in non-social (i.e., mechanistic) domains, and vice versa in positive schizotypy. This thesis investigates how autistic and psychotic-affective phenotypes are associated with usage of two virtual, online media: video games and social media. In line with the diametrical model of social brain disorders, the results show that: 1) females with higher autistic traits exhibit higher video game usage, as well as male-typical genre preferences and motivations, and 2) increased social media usage is associated with a greater prevalence of psychotic spectrum phenotypes, especially those characterized by self-perturbations.

Keywords: Autism; Schizophrenia; Psychosis; Social media; Video games; Technology

Dedication

This work is dedicated to all the young scholars of the future. To the past, or to the future. To an age where thought is free. Hope springs eternal, wherever you are.

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List of Acronyms

AQ	Autism Quotient
ASD	Autism spectrum disorder
BDD	Body Dysmorphia Disorder
DASM	Delusion Amplification by Social Media model
GAMES	Gaming Attitudes, Motives, and Experiences Scales
NPD	Narcissistic Personality Disorder
SFU	Simon Fraser University
SPQ-BR	Schizotypal Personality Quotient-Brief Revised

Chapter 1. Introduction

With recent rapid technological advances, more and more aspects of human imaginative culture have become virtualized and disembodied via video games and social media. For the first time in human evolutionary history, social interactions can take place in entirely disembodied contexts where temporal, spatial, and physical cues can be decoupled and desynchronized from one another. Given the integral role that social selective pressures have had to play in the evolution of the hominoid social brain (Dunbar, 1998), what effects do the recent digitalization of the human social landscape have on socio-cognitive phenotypes and their pathologies? This thesis analyzes how virtualization of aspects of human imaginative culture may be associated with different manifestations and expressions of psychological traits, particularly in the context of non-clinical autistic traits and positive schizotypy.

In accordance with the classic adage “Hell is other people” (Sartre, 1989), social interactions permeate human lives. The evolutionary social brain hypothesis posits that humans have evolved disproportionately large brains to solve increasingly complex social problems found in increasingly complex societies (Dunbar, 1993; 1998). Indeed, specialized neurocognitive modules for face perception (Kanwisher and Yovel, 2006), and social contract processing and cheater detection, have been identified in the human brain (Cosmides, 1989; Cosmides and Tooby, 2015; Fiddick et. al., 2015). Furthermore, humans are also the only primate species that has a relatively large and visible sclera-to-eye ratio that may have evolved for complex non-verbal communication via shared eye contact (Kobayashi and Kohshima, 2008). Humans are also the only primates that have the capacity for abstract and metaphorical speech (Lieberman, 1991), which may have evolved for purposes of complex and implicit meta-communicative signalling (Bateson, 1972). Altogether, the above lines of evidence indicate that the human brain has evolved as a specialized functional adaptation for processing social information.

According to Crespi and Go (2015), all adaptations are constrained by evolutionary trade-offs due to biological limits and physical laws. In this view, sub-optimal deviations from equilibrated adaptations may result in maladaptation, or disorders (Crespi and Go., 2015). As an adaptation, the hominoid social brain has evolved to solve statistically recurrent survival and reproductive problems in ancestral environments (Buss, 1995;

Tooby and Cosmides, 2016), such as establishing social alliances, winning social support, hunting game, courting mates, and maintaining relationships (Buss, 1995). Indeed, humans have largely evolved in living in small, kin-based groups, subsisting on a hunter-gatherer lifestyle with basic tools and minimal technology (Buss, 1995). Leisure time would have been spent in group activities such as socializing, storytelling, dancing, or singing (Wiessner, 2014) – all activities instantiated in shared embodiment (e.g.: looking at each other's facial expressions, moving bodies and voices together). In addition, anthropologists have observed that individuals almost spent little time alone in traditional foraging societies (Hewlett et al., 2019). Altogether, the hominoid brain has evolved in socially cohesive and intimate contexts where there is substantial attunement of one another's intra- and inter-corporeal states via shared activities. In this light, given the recent expansion of virtual technology in the human social landscape, what sort of impact will social electronics have on the expression and manifestation of psychological traits and disorders?

Technology has revolutionized the human imaginative culture in the following ways. First, the ubiquity and accessibility of streaming devices/services may have led to the progressive decline of shared cultural narratives (Baumeister and Robson, 2021). In other words, whereas people used to come together to partake in a session of storytelling or to watch a show together, people can now personally curate their very own "entertainment reality" by picking what sort of online content (e.g. Netflix shows, Youtube, podcasts) to consume on individual electronic devices (e.g. smartphones, tablets). In this light, the 24/7 availability of personally curated online content means that individuals may be increasingly less likely to be embedded in a shared meta-reality via popular culture consumption (Baumeister and Robson, 2021). Such recent technological changes in media consumption may lead to decreased feelings of belonginess (Baumeister and Robson, 2021) and increases in online ideological echo chambers (Brugnoli et al., 2019) – both technologically-driven phenomenon that fracture and polarize individual social media users from a shared social reality. Second, the increasing accessibility of video games may have also led to increasingly atomized play spaces where players can now play "cooperative" games (e.g., Massive Multiple Role Player Games) alone (i.e.,: physically isolated in their rooms on their personal gaming consoles). Instead of conducting social games in-person and negotiating game rules via shared social consensus, video games have introduced an evolutionarily novel medium

where individuals can play “together” without ever making in-person contact. Third, the rise of social media platforms has led to a virtual space of “hyperconnectivity” where anyone anywhere can “befriend” another person by signing up for an online social media account and joining another user’s social media newsfeeds. Now, instead of being embedded in a small kin-based network of approximately 150 individuals, the modern social media user can have up to thousands of Facebook “friends” or millions of Twitter “followers” – both of which would have been impossible prior to the advent of social networking sites. Together, rapid technological advances in the last hundred years have led to multiple evolutionary unprecedented changes in the human imaginative culture as individuals become increasingly atomized, disembodied, and isolated in virtual reality mediums with fewer and fewer in-person opportunities to connect. Given that the online technology is an evolutionary novelty, how does their ubiquity lead to trait-environment mismatches that may manifest in maladaptation or disorders in the human social brain?

Autism and psychotic-affective disorders, such as schizophrenia and positive schizotypy, are two major suites of neurodevelopmental disorders characterized by social impairments (American Psychiatric Association, 2013). Both disorders share overlapping, albeit opposite, symptoms in domains in sociality, imagination, speech, play, interpersonal relations, and embodiment (Crespi and Badcock, 2008; Crespi et al., 2016; Crespi and Dinsdale, 2016). According to the Crespi and Badcock (2008) diametric model of social brain disorders, autism and psychosis may be considered as two extreme ends on a single continuum of socio-cognitive development, a gradient characterized by respective trade-offs in the development of social (i.e., mentalistic) vs. non-social (i.e., mechanistic) domains at each end. In other words, autism may be conceptualized as a disorder of hypo-development in mentalism and hyper-development in mechanism, and vice versa in psychotic-affective conditions.

The word autism originates from the Greek work “autos”, or self, and “-ism”, and tends to involve symptoms of extreme alone-ness (Kanner, 1943), as well as decreased social interests and motivation (Chevallier et al., 2012). For example, autistic traits are typified by decreased eye contact (Senju and Johnson, 2009; Madipakkam et al., 2017), decreased joint attention (Bruinsma et al., 2004), decreased theory-of-mind (Baron-Cohen, 2000), reduced social imagination (Crespi et al., 2016), decreased pretend play (Jarrold, 2003), and a relatively rigid self-other boundary (Noel et al., 2017) – all of which indicate a more self-oriented, less other-oriented, and decreased mentalistic socio-

cognitive style that lends itself toward obduracy against the wider external social world. Conversely, autistic traits have been associated with enhanced mathematical skills (Baron-Cohen et al., 2007), a systemizing cognitive style (Krajmer et al., 2010), increased participation in post-secondary STEM fields (i.e., Science, Technology, Engineering, Mathematics) (Wei et al., 2013) – all of which are suggestive of increased mechanistic development. Furthermore, in children with autism, play tends to be solitary, focused on objects, and repetitive (Holmes and Willoughby, 2005; Blanc et al., 2005; Jarrold, 2003). Altogether, play behaviours in the autistic phenotype are more consistent with a less mentalistic, and more mechanistic "rule-based" systemizing cognitive style that is self-contained and less oriented to the external social world.

In contrast to autism, psychotic-affective conditions, such as schizophrenia and positive schizotypy, are characterized by excessive or hyper-developed social cognition (Crespi and Badcock, 2008). For example, psychotic traits commonly involve paranoia (i.e., excessive or illusory eye contact), delusions or ideas of reference (i.e., excessive or illusory intentionality), and delusions of conspiracy or persecution (i.e., excessive or illusory social narratives) (Crespi and Badcock, 2008). Furthermore, whereas autism has been linked to a more rigid self-other boundary (Crespi and Dinsdale, 2019), schizophrenia is characterized by a weaker, more porous self-other boundary (Noel et al., 2017; Crespi and Dinsdale, 2019; Sass and Parnas, 2003). In contrast to "mind-blindness" in autism where individuals are unaware of another person's feeling states (Frith, 2001), individuals with schizophrenia report experiences of "hyper-attunement" of other peoples' feeling-states, to the point of feeling invaded, "flooded", or "merged" with another person ("When I watch a person or a thing, I become a part of it") (Stanghellini and Ballerini, 2011). The current data thus suggest that the autistic and psychotic-affective spectrum conditions may not only differ in opposite directions with regards to the mentalistic-mechanistic axis, but such differences may also be mediated by aberrations in the self-other polarities, both of which may be instantiated in shared embodiment (i.e., participatory sense making) via coordinated, in-person social interactions (Fuchs, 2009; De Jaegher, 2013). However, how such differences may manifest in virtual, compared to in-person, realities have yet to be systematically investigated.

In short, although preliminary evidence indicates that the autistic and schizotypal phenotypes vary in opposite directions with respect to their social imaginative traits

(Crespi et al., 2016) how the differences may emerge in virtual media (e.g: video games, social media platforms) in the context of an evolutionary framework have yet to be investigated. This thesis addresses this current research gap by studying how non-clinical autistic and schizotypal traits may be associated with patterns in video game and social media usage, two major proxies of virtual social behaviours (i.e., play and social interactions), and both of which have come to dominate modern forms of leisure social interactions. Indeed, some scholars consider the recent technological advances to be the “fourth industrial revolution” (Schwab, 2017), with profound and long-reaching implication for engendering novel evolutionary mismatch disorders, such as so-called “digital depression” (Ghaemi, 2020).

1.1. Video Games and Play

The iconic platform Facebook was introduced in 2004; the first mainstream video game “Pong” in 1972. Together, the existence of video games and social media have lasted less than a hundred years – a temporal eyeblink on the evolutionary timescale. In this light, what effects could virtual technology have on human play and social behavioural adaptations?

But first, why do people play? According to Darwin (1896 p. 69), 'Happiness is never better exhibited than by young animals, such as puppies, kittens, lambs..., when playing together, like our own children”. Although play may take many forms, mammalian play behaviours generally contain the following attributes. First, play is generally only observed in juvenile mammals, and may serve a preparatory role for helping juveniles to learn or practice skills later used in adulthood (e.g., play-fighting) (Pellegrini et al., 2007; McGhee, 1979; Burghardt, 2005; Spinka et al., 2001; Einon and Potegal, 1991; Smith, 1982). Play is also spontaneous, voluntary, intrinsically pleasurable, and only occurs in relatively safe contexts (Huizinga, 2006; Wang and Aamodt, 2012). In addition, play can be broadly categorized into several forms, such as locomotor play (e.g., rough-and-tumble), social play, and object play – all of which overlap to different degrees (Burghardt, 2005; Fagen, 2002; Martin and Caro, 1985). Although almost all mammalian young engage in play behaviours, only humans engage in complex pretend play that involves high degree of abstraction and imagination not observed in other primates. Furthermore, unlike most mammals, humans engage in play behaviours throughout their

lives, even in adulthood (e.g., sports, board games) (Astolfi, 2012). But what is so special about pretend play? And how do video games change, if at all, the nature of human pretend play?

Pretend play involves increased development of the social brain as it involves several mentalistic processes and abstraction (Crespi et al., 2016), including counterfactual reasoning, symbolic representation of objects, and manipulation of “as-if” rules in “quarantined” temporal states (i.e., a child may act as if he were Superman, but understand that it is not real once the game ends) (Weisberg, 2015). Furthermore, pretend play is universal cross-culturally, emerging around 12-18 months of age and peaking at around 3-5 years – all of which suggest that it is a key ontogenetic stage subserving higher socio-cognitive functions. (Piaget, 1962; Haight and Miller, 1993; Lillard, 2017). In humans, pretend play may be unique in that even adults practice some variants thereof, such as improvisational theatre (Göncü and Perone, 2005). Pretend play has also been linked to adulthood creativity (Russ, 2016), divergent thinking (Hoffman and Russ, 2012), perspective-taking (Russ, 2014), narrative-production (Engel, 2005), and theory-of-mind abilities (Leslie, 1987) – all of which involve social imaginative faculties. Indeed, most social pretend play games involve coordination and attunement of mental states and joint attention – an inter-corporal enterprise that involves coordination and synchronization of embodied feeling-states. For example, “playing house” would require children to negotiate and take on different parental roles, and such negotiation would require constant, on-going coordination and attunement of facial expressions, speech, body movements, narratives, as well as adopting different “scripts” of what it means to be “dad” or “mom” depending on what the other person doing. Throughout human evolutionary history, such coordination has only taken place in embodied, iterated, in-person social interactions. The advent of videos games has revolutionized the essence of “play” by eroding both spatial and temporal limitations and restrictions on such games. In-game roles, scripts, and personas are now “pre-made”, disembodied, and replaced by virtual avatars instead of individuals coming together and “imagining” entities into existence. Given that virtual video games have existed less than fifty years, what implications and effects could they have on human social imaginative culture?

This thesis propose that video games may have revolutionized the human play space in the following ways. First, individuals can now play “together” without any face-to-face

interactions with the use of virtual avatars. Second, video games offer a plethora of "pre-packaged" fantasy environments where software engineers pre-program environments with relatively systemized and objective goals/parameters that players can use to progress further in the game. Unlike more "traditional" games where individuals must physically assemble in the same space, spontaneously imagining, abstracting, and negotiate game rules or roles via shared social consensus, video game players can now join any pre-made fantasy world without having to spontaneously imagine any entities into existence by themselves. Third, the popularity of online games means that any individuals can play "together" socially, but ultimately remain "alone" in their atomized, real-life spaces.

Given the importance of pretend play in human social cognitive development (Stagnitti and Unsworth, 2000), how will the virtualization of the human play space be associated with psychological traits, and vice versa?

As discussed above, the Crespi and Badcock (2008) diametrical model of social brain disorders posits autism and psychosis as two extreme ends of a single continuum of socio-cognitive development, with normality at its centre, grading into psychopathology at each end. Previous research has consistently observed a positive relationship between autism and video game usage, particularly problematic video game usage (Murray et al., 2021; Craig et al., 2021). Furthermore, Wendt et al. (2019) reported a positive genetic correlation of computer game use with autism risk, and a negative genetic correlation of computer game use with schizophrenia risk. Given that autistic traits have been linked to decreased in childhood pretend play (Jarrold, 2003) and increased solitary and object play (Holmes and Willoughby, 2005) – both of which are relatively more mechanistic-oriented (e.g. spinning wheels on a truck) and thus less mentalistic-inclined. In addition, children with autism are also less likely to have imaginary companions compared to their neurotypical peers (Davis et al., 2018) In contrast, positive schizotypal traits (i.e., Unusual experiences) are associated with greater likelihood of having childhood imaginary companions (Zarei, 2022). In addition, adolescents who reported having imaginary companions also reported higher levels of paranoid ideation and psychoticism (Bonne et al., 1999). According to Svendsen (1934, p. 988), an imaginary companion is "an invisible character named and referred to in conversation with other persons or played with directly for a period of time, at least several months, having an air of reality for the child, but no apparent objective basis" (p.

988). Thus, the creation and maintenance of imaginary companions would necessitate high expression of social imaginative and meta-representational abilities (Singer and Singer, 1990; Taylor, 1999), both of which are increased in psychotic-affective spectrum conditions (Crespi et al., 2016). Given the above, current data suggest that autistic and schizotypal traits may also be associated with opposite patterns in pretend play behaviours – a pattern that may extend into the virtual space.

Although current, preliminary evidence suggests that the autism and schizotypy may vary in opposite directions with regards to play behaviours, there is currently no research that directly compares non-clinical autistic and schizotypal traits in relations to play behaviours in virtual media such as video games. Thus, Chapter 1 addresses the current knowledge gap by testing whether non-clinical autistic and positive schizotypal traits will be associated with opposite patterns of video game usage, with autistic traits predicting greater video game usage and positive schizotypy predicting lowered video game usage. This work also investigates whether autistic and schizotypal video game genre preferences and motivation vary along the mechanistic-mentalistic axis.

1.2. Social media and social brain disorders

Like video games, social media platforms have revolutionized human social interactions by introducing a disembodied platform where almost anyone anywhere can “connect” with another person with an online account by “following” or “friending” them. In 2021, 84% of adult Americans (age 18 – 29) reported having used social media sites, with 95% of this cohort being users of YouTube (Pew Research Center, 2021). Seven in ten Facebook users report using the site daily, including 49% who say that they use the site several times per day (Pew Research Center, 2021). For the first time in human evolutionary history, normally embodied and socially interactive processes such as eye contact, identity, social relationships, and joint attention are decoupled and granularized into virtual subcomponents via online “view” counts, Instagram and Snapchat “stories”, digital personas, number of “friends/followers”, and online “likes/hearts” as proxies of virtual interactions. As more and more users migrate online for their perceived social needs, what implications and impacts could this have on psychological traits, and vice versa?

Most mainstream social media platforms (e.g. Facebook, Instagram, Youtube) are largely visually-driven and performative in nature, and thus may require high expression of mentalistic traits for successful usage. For example, to make a successful Youtube video with a high viewer count, an individual must attend and perform in front of an imaginary audience by constantly anticipating, inferring, and imagining what the virtual audience would want to see, without real-time in-person feedback. As such, successful social media usage may engender high expression of mentalistic traits, particularly those concerning social imagination, such as illusory (virtual) eye contact, joint attention, social narratives, and theory-of-mind skills – all of which are relatively enhanced in individuals with psychotic-affective spectrum traits (Crespi et al, 2016; Crespi and Badcock, 2008).

Given that autism and positive schizotypy are characterized by opposite traits in the mentalism-mechanism axis, can such differences be extended into the virtual social space via patterns of social media usage? As discussed above, autism is characterized by hypo-development in mentalistic cognition (Crespi and Badcock, 2008), which may lend itself toward decreased social media usage via reduced interests in social interactions. In contrast, non-clinical psychotic-spectrum traits (i.e., healthy schizotypy) are generally characterized by increased creativity (Burch et al., 2006; Nettle and Clegg, 2006), imagination (von Stumm and Scott, 2019; Crespi et al., 2016), and theory-of-mind skills (Crespi and Badock, 2008) – all characteristics that would make for a successful online content producer and thus more likely to be associated with greater social media usage. Furthering this view, we predict that different subdomains of mentalistic cognition will manifest in different patterns of social media usage in both non-clinical and clinical populations, with psychopathologies (e.g.: psychosis) more likely to manifest in the latter group with increased usage.

To explore the diametric model within the social media space, Chapter 2 presents a narrative review on the relationships between social media usage and autism and psychotic-spectrum condition via two different levels of analysis: (1) a disorder-level view that includes a broad swath of conditions such as psychosis, schizophrenia, positive schizotypy, borderline personality disorder, narcissistic personality disorder, body dysmorphia, eating disorders, all in relation to social media use, and (2) a trait-level view that analyzes key mentalistic traits such as paranoia, social relationships, social status monitoring, reality perception, and dissociation.

In summary, both video games and social media platforms provide evolutionarily novel platforms where social and play behaviours can be entirely disembodied, dissociated, desynchronized, and granularized via virtual means – all of which may yield evolutionarily unprecedented impacts on the expression and manifestations of socio-cognitive traits. By investigating how autistic and positive schizotypal traits may vary in two different social virtual media, this thesis seeks to understand how social technology may influence expression and development of mechanism and mentalistic traits along the autism-schizotypy axis, particularly in the domains of play and social interactions.

1.3. References

American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders. 5. Washington, DC: American Psychiatric Association.

Astolfi, M. T. (2012). (Unpublished results). The evolutionary psychology of video games: The digital game as supernormal stimulus (Master thesis). New York University.

Baron-Cohen, S. (2000). Theory of mind and autism: A review. Int. Rev. Res. Ment. Retard., *23*, 169-184. doi:10.1016/S0074-7750(00)80010-5

Baron-Cohen, S., Wheelwright, S., Burtenshaw, A., and Hobson, E. (2007). Mathematical talent is linked to autism. Hum. Nat., *18*(2), 125-131. doi:10.1007/s12110-007-9014-0

Bateson, G. (1972). “A theory of play and fantasy,” in Semiotics: An Introductory Anthology, edited by R. E. Innis (Bloomington, IN: Indiana University Press.), 131-144.

Baumeister, R. F., and Robson, D. A. (2021). Belongingness and the modern schoolchild: On loneliness, socioemotional health, self-esteem, evolutionary mismatch, online sociality, and the numbness of rejection. Aust. J. Psychol., *73*(1), 103-111. doi:10.1080/00049530.2021.1877573

Bekoff, M. (2001). Social play behaviour. Cooperation, fairness, trust, and the evolution of morality. J. Conscious. Stud., 8(2), 81-90.

Blanc, R., Adrien, J. L., Roux, S., and Barthélémy, C. (2005). Dysregulation of pretend play and communication development in children with autism. *Autism*, *9*(3), 229-245. doi:10.1177/136236130505325

Bonne, O., Canetti, L., Bachar, E., De-Nour, A. K., and Shalev, A. (1999). Childhood imaginary companionship and mental health in adolescence. Child Psychiatry Hum. Dev., 29(4), 277-286. doi:10.1023/A:1021345015520

Brugnoli, E., Cinelli, M., Quattrociocchi, W., and Scala, A. (2019). Recursive patterns in online echo chambers. Sci. Rep., 9(1), 1-18. doi:10.1038/s41598-019-56191-7

Bruinsma, Y., Koegel, R. L., and Koegel, L. K. (2004). Joint attention and children with autism: A review of the literature. Ment. Retard. Dev. Disabil. Res. Rev., 10(3), 169-175. doi:10.1002/mrdd.20036

Burch, G. S. J., Pavelis, C., Hemsley, D. R., and Corr, P. J. (2006). Schizotypy and creativity in visual artists. Br. J. Psychol., 97(2), 177-190. doi:10.1348/000712605X60030

Burghardt, G. M. (2005). The genesis of animal play: Testing the limits. (Cambridge, MA: MIT press).

Buss, D. M. (1995). Evolutionary psychology: A new paradigm for psychological science. Psychol. Inq., *6*(1), 1-30. doi:10.1207/s15327965pli0601_1

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E. S., and Schultz, R. T. (2012). The social motivation theory of autism. Trends. Cogn. Sci., 16(4), 231-239. doi: 10.1016/j.tics.2012.02.007

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. Cognition, *31*(3), 187-276. doi:10.1016/0010-0277(89)90023-1

Cosmides, L., and Tooby, J. (2015). Neurocognitive adaptations designed for social exchange. *The handbook of evolutionary psychology*, 584-627. doi:10.1002/9780470939376.ch20

Craig, F., Tenuta, F., De Giacomo, A., Trabacca, A., and Costabile, A. (2021). A systematic review of problematic video-game use in people with Autism Spectrum Disorders. Res. Autism Spectr. Disord., *82*, 101726. doi:10.1016/j.rasd.2021.101726

Crespi, B. J., and Go, M. C. (2015). Diametrical diseases reflect evolutionary-genetic tradeoffs: evidence from psychiatry, neurology, rheumatology, oncology and immunology. Evol. Med. Public Health, *2015*(1), 216-253. doi:10.1093/emph/eov021

Crespi, B., and Badcock, C. (2008). Psychosis and autism as diametrical disorders of the social brain. Behav. Brain Sci., 31(3), 241-261. doi:10.1017/S0140525X08004214

Crespi, B., and Dinsdale, N. (2019). Autism and psychosis as diametrical disorders of embodiment. Evol. Med. Public Health, 2019(1), 121-138. doi:10.1093/emph/eoz021

Crespi, B., Leach, E., Dinsdale, N., Mokkonen, M., and Hurd, P. (2016). Imagination in human social cognition, autism, and psychotic-affective conditions. Cognition, *150*, 181-199. doi:10.1016/j.cognition.2016.02.001

Darwin, C. (1896). Charles Darwin's Works: The descent of man and selection in relation to sex. (New York, NY: D. Appleton.), Vol. 9.

Davis, P. E., Simon, H., Meins, E., and Robins, D. L. (2018). Imaginary companions in children with autism spectrum disorder. J. Autism Dev. Disord., 48(8), 2790-2799. doi:10.1007/s10803-018-3540-y

De Jaegher, H. (2013). Embodiment and sense-making in autism. Front. Integr. Neurosci., 7, 15. doi:10.3389/fnint.2013.00015

Dunbar, R. I. (1993). Coevolution of neocortical size, group size and language in humans. Behav. Brain. Sci., *16*(4), 681-694. doi:10.1017/S0140525X00032325

Dunbar, R. I. (1998). The social brain hypothesis. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews*, *6*(5), 178-190. doi:10.1002/(SICI)1520-6505(1998)6:5<178::AID-EVAN5>3.0.CO;2-8

Einon, D., and Potegal, M. (1991). Enhanced defense in adult rats deprived of playfighting experience as juveniles. Aggress. Behav., 17(1), 27-40. doi:10.1002/1098-2337(1991)17:1<27::AID-AB2480170105>3.0.CO;2-B

Engel, S. (2005). The narrative worlds of what is and what if. Cogn. Dev., 20(4), 514-525. doi:10.1016/j.cogdev.2005.08.005

Fagen, R. (2002). “Primate juveniles and primate play,” in Juvenile Primates: Life History, Development, and behaviour, ed. M. E. Pereira, and L. A. Fairbanks (New York, NY: University of Chicago Press.), 182-196.

Fiddick, L., Spampinato, M. V., and Grafman, J. (2005). Social contracts and precautions activate different neurological systems: An fMRI investigation of deontic reasoning. *NeuroImage*, *28*(4), 778-786. doi:10.1016/j.neuroimage.2005.05.033

Frith, U. (2001). Mind blindness and the brain in autism. *Neuron*, *32*(6), 969-979. doi:10.1016/S0896-6273(01)00552-9

Fuchs, T. (2009). Embodied cognitive neuroscience and its consequences for psychiatry. *Poiesis Prax.*, *6*(3), 219-233. doi:10.1007/s10202-008-0068-9

Ghaemi, S. N. (2020). Digital depression: a new disease of the millennium?. Acta Psychiatr. Scand., 141(4), 356-361. doi:10.1111/acps.13151

Göncü, A., and Perone, A. (2005). Pretend play as a life-span activity. *Topoi*, *24*(2), 137-147. doi:10.1007/s11245-005-5051-7

Hewlett, B. S., Hudson, J., Boyette, A. H., and Fouts, H. N. (2019). “Intimate living: sharing space among Aka and other hunter-gatherers,” in Towards a broader view of hunter-gatherer sharing, ed. N. Lavi and D. E. Friesem (Cambridge, UK: McDonald Institute for Archaeological Research.), 39-52.

Hoffmann, J., and Russ, S. (2012). Pretend play, creativity, and emotion regulation in children. Psychol. Aesthet. Creat Arts, 6(2), 175–184. doi:10.1037/a0026299

Holmes, E., and Willoughby, T. (2005). Play behaviour of children with autism spectrum disorders. J. Intellect. Dev. Disabil., 30(3), 156-164. doi:10.1080/13668250500204034

Huizinga, J. (2006). Nature and significance of play as a cultural phenomenon. *The game design reader: A rules of play anthology*, pp.96-120.

Jarrold, C. (2003). A review of research into pretend play in autism. Autism, 7(4), 379-390. doi:10.1177/1362361303007004004

Kanner, L. (1943). Autistic disturbances of affective contact. Nervous child, 2(3), 217-250.

Kanwisher, N., and Yovel, G. (2006). The fusiform face area: a cortical region specialized for the perception of faces. Philos. Trans. R. Soc. Lond., B, Biol. Sci., 361(1476), 2109-2128. doi:10.1098/rstb.2006.1934

Kobayashi, H. and Kohshima, S. (2008). “Evolution of the human eye as a device for communication.” In: Primate origins of human cognition and behavior. Springer, Tokyo. p. 383-401. doi:10.1007/978-4-431-09423-4_19

Krajmer, P., Janosikova, D., Spajdel, M., and Ostatnikova, D. (2010). Empathizing, systemizing, intuitive physics and folk psychology in boys with Asperger syndrome. Act. Nerv. Super. Rediviva, 52(1), 57-61.

Lieberman, P. (1991). Uniquely human: The evolution of speech, thought, and selfless behavior. Cambridge, MA: Harvard University Press.

Madipakkam, A. R., Rothkirch, M., Dziobek, I., and Sterzer, P. (2017). Unconscious avoidance of eye contact in autism spectrum disorder. Sci. Rep., 7(1), 1-6.doi:10.1038/s41598-017-13945-5

Martin, P., and Caro, T. M. (1985). On the functions of play and its role in behavioral development. Adv. Study Behav. 15, 59-103. doi:10.1016/S0065-3454(08)60487-8

Murray, A., Koronczai, B., Király, O., Griffiths, M. D., Mannion, A., Leader, G., and Demetrovics, Z. (2021). Autism, problematic internet use and gaming disorder: A systematic review. Review J. Autism Dev. Disord., 1-21. doi:10.1007/s40489-021-00243-0

Nettle, D., and Clegg, H. (2006). Schizotypy, creativity and mating success in humans. *Proceedings. Biological sciences*, *273*(1586), 611–615. doi:10.1098/rspb.2005.3349

Noel, J. P., Cascio, C. J., Wallace, M. T., and Park, S. (2017). The spatial self in schizophrenia and autism spectrum disorder. *Schizophr. Res.*, *179*, 8-12. doi:10.1016/j.schres.2016.09.021

Pellegrini, A. D., Dupuis, D., and Smith, P. K. (2007). Play in evolution and development. Developmental review, 27(2), 261-276. doi:10.1016/j.dr.2006.09.001

Pew Research Center, April 2021, “Social Media Use in 2021.” https://www.pewresearch.org/internet/2021/04/07/social-media-use-in-2021/ [Accessed Sept. 15, 2022]

Russ, S. W. (2016). Pretend play: Antecedent of adult creativity. New directions for child and adolescent development, 2016(151), 21-32. doi:10.1002/cad.20154

Russ, S. W., and American Psychological Association. (2014). Pretend play in childhood: Foundation of adult creativity. Am. J. Play. 45-62.

Sartre, J.P. (1989). No Exit and other plays. New York: Vintage Books.

Sass, L. A., and Parnas, J. (2003). Schizophrenia, consciousness, and the self. *Schizophrenia bulletin*, *29*(3), 427-444. doi:10.1093/oxfordjournals.schbul.a007017

Schwab, K. (2017). The fourth industrial revolution. New York: Crown Publishing Group.

Senju, A., and Johnson, M. H. (2009). The eye contact effect: mechanisms and development. Trends Cogn. Sci., 13(3), 127-134. doi:10.1016/j.tics.2008.11.009

Singer, D. G., and Singer, J. L. (1990). The house of make-believe: Children’s play and the developing imagination. Cambridge: Harvard University Press.

Smith, P. K. (1982). Does play matter? Functional and evolutionary aspects of animal and human play. Behav. Brain Sci., 5(1), 139-155. doi:10.1017/S0140525X0001092X

Spinka, M., Newberry, R. C., and Bekoff, M. (2001). Mammalian play: training for the unexpected. Q. Rev. Biol., 76(2), 141-168.

Stagnitti, K., and Unsworth, C. (2000). The importance of pretend play in child development: An occupational therapy perspective. Br. J. Occup. Ther., 63(3), 121-127. doi:10.1177/03080226000630030

Stanghellini, G., and Ballerini, M. (2011). What is it like to be a person with schizophrenia in the social world? A first-person perspective study on Schizophrenic dissociality–part 1: state of the art. Psychopathology, 44(3), 172-182. doi:10.1159/000322637

Svendsen, M. (1934). Children’s imaginary companions. Arch. Neurol. Psychiatry, 32(5), 985–999. doi:10.1001/archneurpsyc.1934.02250110073006.Return to ref 1934 in article

Taylor, M. (1999). Imaginary companions and the children who create them. New York: Oxford University Press on Demand.

Tooby, J., and Cosmides, L. (2016). The theoretical foundations of evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology: Foundations* (pp. 3–87). John Wiley and Sons, Inc..

von Stumm, S., and Scott, H. (2019). Imagination links with schizotypal beliefs, not with creativity or learning. Br. J. Psychol., *110*(4), 707-726. doi:10.1111/bjop.12369

Wang, S., and Aamodt, S. (2012). Play, stress, and the learning brain. Cerebrum, 2012, 12.

Wei, X., Yu, J. W., Shattuck, P., McCracken, M., and Blackorby, J. (2013). Science, technology, engineering, and mathematics (STEM) participation among college students with an autism spectrum disorder. J. Autism Dev. Disord., 43(7), 1539-1546. doi: 10.1007/s10803-012-1700-z

Weisberg, D. S. (2015). Pretend play. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6*(3), 249-261. doi:10.1002/wcs.1341

Wendt, F. R., Muniz Carvalho, C., Pathak, G. A., Gelernter, J., and Polimanti, R. (2019). Deciphering the biological mechanisms underlying the genome-wide associations between computerized device use and psychiatric disorders. J. Clin. Med. 8, 2040. doi:10.3390/jcm8122040

Wiessner, P. W. (2014). Embers of society: Firelight talk among the Ju/'hoansi Bushmen. Proc. Natl. Acad. Sci., *111*(39), 14027-14035. doi:10.1073/pnas.1404212111

Zarei, T., Pourshahbaz, A., and Poshtmashhadi, M. (2022). Childhood Imaginary Companion and Schizotypy in Adolescents and Adults. Journal of Anomalous Experience and Cognition, 2(1), 166-189.

Chapter 2. Why iPlay: the Relationships of Autistic and Schizotypal Traits With Patterns of Video Game Usage

2.1. Abstract

Video games are popular aspects of human imaginative culture, but their relationships to psychological and neurophysiological traits have yet to be analyzed in social-evolutionary frameworks. We examined the relationships of video game usage, motivations, and preferences with autistic and schizotypal traits and two aspects of neurophysiology, reaction time and targeting time. We predicted that: (1) higher autistic scores would predict higher video game usage, and vice versa in positive schizotypy; and (2) autism and positive schizotypy would be associated with opposite patterns of video game use, preferences, and motivations. Females, but not males, with higher autism scores played more video games, and exhibited evidence of relatively male-typical video game genre preferences and motivations. Conversely, positive schizotypy was associated with reduced video game use in both genders. Results suggest that video games may provide an evolutionarily novel medium for imaginative play in which immersive play can be decoupled from social interactions.

Keywords: Autism; Schizophrenia; Video games; Technology; Play; Imagination

2.2. Introduction

Why do people play? Play is a nearly universal behaviour among mammals (Burghardt, 2005), but only humans have the capacity for complex and social pretend play, and for developing the multiple orders of intentionality necessary for narrative production, theory-of-mind, and abstract thinking (Nowell, 2016). Play has also been postulated as a fundamental preparatory adaptation for higher-order adult social behaviours such as competition, reciprocity, and moral development (Bekoff, 2001; Bateson, 2005). There is also evidence that play may be considered a form of proto-creativity, which may underlie higher-order social cognitive processes including imagination, theory-of-mind, and abstract problem-solving (Leslie, 1987; Vygotsky, 1967). For example, in both object and pretend play, there is a transitive process where children spontaneously extract or conjure abstract properties of objects, manipulate or “play” with such constructs, then project them onto other entities. The transitive process of spontaneously conjuring abstract properties and manipulating them among unrelated objects is a hallmark of imagination, creativity, and divergent thinking. Physical play, such as rough-and-tumble play, has also been implicated in the development of social behaviours, such as dominance and cooperation (Smith and Boulton, 1990). Thus, play appears to be a key ontogenetic developmental phase in human social cognitive development.

How, then, does the current digitalization of the social world affect how people play? Given increased virtualization of the social world, video games have come to increasingly predominate the 'iGen' (i.e., the generation of individuals born between 1995 and 2011, who grew up with smartphones and social media) play space (Twenge, 2017). As of 2021, there are nearly 227 million video game players in the U.S., with the median age at 31 years old (Entertainment Software Association, 2021), making video games one of the most popular pastimes enjoyed by people from all age groups. Annual video game sales in the U.S. have also grown from $25 billion in 2016 to $35 billion in 2018 (Entertainment Software Association, 2019), making it one of the most lucrative and fastest growing industries in the entertainment sector. The increasing accessibility and ubiquity of digital technology, such as mobile phones and tablets, have made it possible for most of the population to access games at their fingertips. The increasingly accessibility of video games has also made it possible for games to be incorporated into

a diverse range of day-to-day activities, including but not limited to education, entertainment, rehabilitation, and therapy.

Despite the growing importance and popularity of video games in modern life, the relationships of video game culture with social and cognitive phenotypes remained little understood. To date, most research on video games had focused on specific aspects of neuropsychological traits to video game use, such as the relationship between aggression and violent video games (Scott, 1995), the use of video game in training faster reaction times (Dye et al., 2009), and the effects of Big Five personality traits on video game preferences (Peever et al., 2012). Such work is useful for elucidating the proximate mechanisms underlying video game use but does not capture the overarching questions of how and why video game usage is involved in the larger socio-evolutionary framework of play, social cognitive development, and imaginative culture. In other words, why do people play video games? Why is such play important? What social-cognitive, psychological, and neurophysiological traits are associated with video game usage, preferences, and motivations? And how do video games factor into the evolutionary functions of play in general?

Current evidence suggests that video game usage patterns are consistent with psychological profiles and behaviours that mirror real life motivations and preferences (Delhove and Greitemeyer, 2020; Wang et al., 2019). For example, self-perceived in-game aggression in the First Person Shooter game Overwatch is positively associated with trait aggression, Dark Tetrad, and negatively with empathy and agreeableness in players (Delhove and Greitemeyer, 2020). Multiple lines of evidence also suggest Big Five Personality Traits have a measurable impact in individual patterns of video game usage (Wang et al., 2019; Yang et al., 2020; Tabacchi et al., 2017). For example, extraversion has been positively associated with preference for party, music, and casual games, and negatively with fantasy role-playing, MMORPGs (massively multiplayer online role playing), action role-playing, and strategy games (Peever et al., 2012). Similarly, conscientiousness has been associated with preferences for sport, racing, flight simulation, and fighting games (Peever et al., 2012), which suggests that athletic and action video game genres involve clear and identifiable goals and immediate reinforcement of achievements, and conscientiousness is associated with greater goal orientation (Colquitt and Simmering, 1998). Openness to experience, a personality trait linked with creativity and imagination (McCrae, 1987), has been associated with

preferences for action-adventure and platformer games (Peever et al., 2012), both of which usually involve open exploration of virtual environments and creative puzzle-solving (e.g., Legend of Zelda, Super Mario). Indeed, openness to experience has also been associated with greater motivation to play video games for immersive experiences (Johnson and Gardner, 2010). Individuals with higher social orientation tend to play competitive or multiplayer games such as Call of Duty or World of Warcraft and individuals with high goal orientation prefer exploratory, intrinsically rewarding games such as Minecraft (Tondello and Nacke, 2019).

How, then, does the development of diverse social-psychological phenotypes correlate with general video usage? From the pattern described above, different typologies of video game players may be elucidated further, based on differential development in socio-cognitive traits and usage profiles.

Emerging evidence indicates that video games usage may reflect not only users' psychological traits, but also neurophysiological skills such as reaction time (Dye et al., 2009; Gorbet and Sergio, 2018; Torner et al., 2019; Kowal et al., 2018; Deleuze et al, 2017), spatial visualization (Dorval and Pepin, 1986), multiple object tracking (Green and Bavelier, 2006), better cognitive flexibility in task-switching (Li et al., 2020) and probabilistic inferences on visual perceptual task (i.e., being able to quickly discriminate whether a display of randomly moving dots are moving toward the left or right) that are generalizable across modalities (Green et al., 2010). Furthermore, video game users also exhibit better hand-eye coordination skills than non-users (Griffith et al., 1983), but the question of whether video game usage improves hand-eye coordination times, or whether users with better hand-eye coordination play more videos (or both), is not yet resolved.

Considered together, these results support the view that video game usage patterns are associated with variation in some psychological traits and neurophysiological phenotypes. However, most studies have focused on action games, and no previous work has analyzed subclinical autistic and schizotypal traits (i.e., traits related to social cognition, neurodevelopment, and other phenotypes) together in relation to video game usage and preferences and their neurophysiological correlates. Such studies are important given the important roles of video games of diverse genres in human imaginative culture and given that individuals with autism or schizotypy show some

evidence of high rates of video game usage (Mazurek and Engelhardt, 2013a; Mazurek and Engelhardt, 2013b; Schimmenti et al., 2017; Menear and Ernest, 2020; Coutelle et al., 2021; Choi et al., 2020). This study thus analyzes how video game usage patterns, genre preferences motivations, and reaction times are associated with measures of non-clinical autism and schizotypy.

Two studies suggest that psychological variation related to the autism spectrum and the schizophrenia spectrum, including positive schizotypy, may mediate aspects of video game use. First, Wendt et al. (2019) reported a positive genetic correlation of computer game use with autism risk, and a negative genetic correlation of computer game use with schizophrenia risk. These findings suggest that autism and schizophrenia or schizotypy may show opposite patterns of association with video game use in non-clinical populations, for reasons that have yet to be investigated.

Second, according to the diametric model of social brain disorders (Crespi and Badcock, 2008; Crespi, 2016; 2019; 2020; Crespi and Go, 2015), autism and psychosis can be conceptualized as ends of a continuum of social cognition development, with normality at its center. Thus, autism is characterized by low mentalistic thought (i.e., social cognition) and high mechanistic thought (i.e., non-social cognition), and psychotic-affective conditions, such as schizotypy, are characterized by high mentalistic and low mechanistic thought (Crespi and Badcock, 2008). Given that childhood play can be categorized in non-social (i.e., object) and social (i.e., pretend or imaginary) domains, video game usage patterns may be expected to co-vary according to the socio-cognitive traits in autistic and schizotypal spectrum.

Mechanistic thought is characterized by a cognitive style specialized for recognizing patterns in rule-based systems (i.e., “if p, then q”) (Baron-Cohen et al., 2009). In autism, a systemizing cognitive style is applicable to a broad swath of domains such as collectibles (i.e., distinguishing between types of objects and collecting them), motoric (i.e., throwing a Frisbee), mechanical (i.e., taking apart objects and reassembling them), spatial (i.e., fixed interests with routes), action sequences (i.e., analyzing dance techniques), and numerical traits (i.e., solving math or logical problems) (Baron-Cohen et al., 2009) – all of which are conducive for puzzles, action, platformer, sports, and construction simulation types of video games where extensive strategizing of rule-based systems is involved. Indeed, previous studies have found that individuals with autism

prefer gaming genres such as Action, Platformer, and Shooter (Kuo et al., 2013; Mazurek and Engelhardt, 2013b), all of which challenge the player's coordination, and speed in rule-based gameplay. A strong systemizing style can also involve especially high attention to details and fast sensory processing (Baron-Cohen et al., 2009), which may facilitate higher video game usage by enhancing attentional focus, reaction times and hand-eye coordination.

Furthermore, autistic traits have been associated with higher video game usage (Mazurek and Engelhardt, 2013b), and problematic video game usage (i.e., symptoms of clinical addiction to video games) (Coutelle et al., 2021; Craig et al., 2021; Murray et al., 2021; Liu et al., 2017). Compared to neurotypicals, boys and male adolescents with ASD also play video games for longer times, preferred to play alone, and play less frequently in multiplayer mode (Paulus et al., 2019). Taken together, autistic traits may thus involve higher video game usage, as well as increased preferences for puzzle, action, platformer, strategy, racing, sports, idle, and construction and management simulation games. Given the positive association of action video games with autistic traits, we also expect that autistic traits in nonclinical individuals may also be positively associated with increased neurophysiological skills such as faster reaction and hand-eye coordination times.

In contrast to autism, positive schizotypy can be characterized by hyper-mentalistic traits such as fantasy-proneness, ideas of reference (i.e., illusory social references to self), paranoia (e.g., illusory eye contact and fear), and increased imagination (Crespi and Badcock, 2008; Crespi et al., 2016). All these traits may be expected to increase preferences for fantasy or fantasy-based role-playing video games that are extensions of pretend play. In contrast to autism, which is known for its singular focus on select topics of special interests (Casey et al., 1993), schizotypy is associated with information processing impairments such as poor sustained attention (Lenzenweger et al., 1991), deficits in sensorimotor gating (i.e., inability to filter out irrelevant stimuli from the environment) (Cadenhead et al., 2000; Park et al., 2015), and deficits in smooth eye pursuits (Lenzenweger and O'Driscoll, 2006) – all traits that may make video games challenging, as they commonly involve detecting and tracking sudden and fast-moving objects and distractors while multi-tasking (Hubert-Wallander et al., 2011).

Positive schizotypal traits, in particular, have been associated with slower reaction time during conditions of high perceptual load (Lenzenweger, 2001) and deficits in predicting targeting hand movements (Asai et al., 2008), both of which would impede video gameplay, particular action genres, as a large component of gameplay involve fast decision-making and quick executions of hand-eye movements via controller use. Thus, positive schizotypal traits may be associated with decreased video game usage, as well as a preference for fantasy or fantasy-based role-playing video games, which tend to be slower-paced and emphasize user-directed exploratory behaviour rather than time-intensive tasks.

Gender differences in play have been well-documented in the literature, extending into video game usage and preferences. Male play is more physically aggressive (Ostrov and Keating, 2004) and “thing-oriented”, with increased interests in objects and functions of objects such as construction and transportation (Servin et al., 1999). In comparison, female play tends to be more socially directed and involve fantasy-role playing, such as play parenting (i.e., doll playing), a sex difference that has been observed in primates (Pryce, 1995), and pretend play (i.e., toy tea-sets) (Servin et al., 1999). Preliminary lines of evidence suggest that sex differences in childhood play may also extend to the video game usage. For example, college-aged males prefer more physical aggressive video game genres such as action, racing, and sports (Greenberg et al., 2010). In contrast, females prefer to prefer more “traditional” games such as puzzles, cards, classic arcade games, or board games (Greenberg et al., 2010), all of which are less physically aggressive. Thus, sex differences in patterns of video game usage, genre preferences, and motivations might be expected to reflect general sex differences in childhood play.

Based on the reasons outlined above, the following predictions can be made:

Hypothesis 1: Gender differences in video game usage, genre preferences, and motivations will vary in the following ways: (1) Males will report greater video game usage than females, (2) Males will prefer mechanistic-oriented video games such as Action, Platformer, Strategy, Racing, Sports, RPG, and Construction and Management Simulation games while females will prefer Puzzle and Social Simulation video games, (3) Males will report greater motivation for Skill Development and Customization games and females will report greater motivations of Social Interaction, a Way to Fantasize, and a Way to Escape on the Video Game Usage Questionnaire used here.

Hypothesis 2: Autistic traits will be associated with increased video game usage. Total and positive schizotypal traits, as quantified by total score on the SPQ-BR and scores on the SPQ Cognitive-Perceptual subscale, will be negatively associated with frequency of video game usage.

Hypothesis 3: Autistic traits will be positively associated with preferences for relatively rule-based video game genres including Puzzle, Action, Platformer, Strategy, Racing, Sports, Idle, and Construction and Management Simulation games. Total and positive schizotypal traits will be positively associated with preferences for fantasy Role-Playing and Social Simulation video games.

Hypothesis 4: Autistic traits will be positively associated with mechanistic motivations such as Skill Development and Customization on the Video Game Usage Questionnaire. Total and positive schizotypal traits will be positively associated with mentalistic motivations such as Social Interaction, Way to Fantasize, and Way to Escape on the Video Game Usage Questionnaire used here.

Hypothesis 5: Autistic traits will be associated with increased neurophysiological skills, such as faster reaction time and hand-eye coordination time. Conversely, total and positive schizotypal traits will be associated with slower reaction and hand-eye coordination times.

Hypothesis 6: Increased total video game usage will be predicted by higher reaction and hand-eye coordination time. In turn, slower reaction and hand-eye coordination time will predict lower video game usage.

The predictions of these hypotheses were tested using data on measures of autism spectrum and schizotypy spectrum cognition in a non-clinical population, and data on reaction times and targeting times, two measures of neurophysiological performance that may be related to video game use and performance.

This study will only interpret p-values as significant if they meet with the a priori predictions. This is a preliminary study and other significant results will be regarded as exploratory and require replication in future studies.

2.3. Materials and Methods

Participants

A total of 351 participants (207 females, 144 males, mean age = 20.20 ± 3.04 years old) were included in the study. The participants were recruited from various electronic mailing lists (i.e., university student lists and newsletters) and the Simon Fraser University Undergraduate Psychology Research Pool. The following study description was circulated as the recruitment email: “Do you play video games? Or do you not play video games? Either way, we want to hear from you! We are doing an online study on the relationship between psychological traits and video game usage. You will receive a $10 gift card for participation. For more info please contact Nancy Yang”. Participants were reimbursed with either a course credit or a $10 electronic gift card for their time. All participants provided informed consent before participating in this study. Data collection took place during the Spring 2021 semester (January – April 2021). The study was approved by the Simon Fraser University Research Ethics Board (Study Permit 2020s0503).

Psychological Questionnaires

The Autism Spectrum Quotient (AQ) was used to assess individual variations in autistic traits (Baron-Cohen et al., 2001). The AQ comprises 50 questions assessing five different domains: i.) social skills, ii.) attention switching, iii.) attention to detail, iv.) communication, v.) imagination. Responses were scored in a 4-point Likert-scale format from “definitely agree” to “definitely disagree”. Participants score one point when they report a trait that is consistent with the autism spectrum, for a possible scoring range of 0-50. Higher scores on the Social Skills and Imagination subscale represent lower social skills and lower social imagination.

Schizotypal traits were quantified with Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR) (Cohen et al., 2010). The SPQ-BR includes 32 items in a 5-point Likert scale format with response choices ranging from ‘strongly disagree’ to ‘strongly agree’. Possible scores range from 0 to 160, with higher scores indicative of higher levels of schizotypy. The SPQ-BR is clustered into three super-ordinate factors: Cognitive-Perceptual, Interpersonal, and Disorganized schizotypy – which map onto the

positive, negative, and disorganized dimensions of schizophrenia, respectively (Andreasen et al., 1995). The Cognitive-Perceptual (positive) schizotypy scale (referred to here as SPQ-CogPer) consists of three subscales: Magical Thinking, Unusual Perceptions, and Ideas of Reference. The Interpersonal schizotypy factor includes Social Anxiety and Constricted Affect, and the Disorganized factor includes Eccentric Behaviour and Odd Speech.

A Video Game Usage Questionnaire was adapted from the Gaming Attitudes, Motives, and Experiences Scales (GAMES) (Hilgard et al., 2013). The questionnaire has six main sections to assess patterns of video game usage, as well a short demographic section that asks participants to report their age and gender (e.g. male, female, other, prefer not to answer). First, participants were asked the amount of weekday and weekend hours spent on video games, as well as self-evaluations of video game usage. Participants are also asked the titles of the video games that they play, preferred types of video game genres, motivations for gaming (i.e., Social Interactions, Stress Relief, Skill Development, Adrenaline Rush, A Place to Escape, A Way to Fantasize, Customization), self-evaluations of video game performance, as well as preferred type of device for playing video games. For game titles, participants were given a list of popular video games to choose from, as well as write their own response in an open-ended “Other” answer box. For video game genres, participants were given the following list to choose from, as well as brief examples of what each genre entails. The list of video game genres was as follow: Puzzle games (candy crush, portal), Action games (first-person shooter like Doom, Call of Duty), Platformer games (side scrolling games like Mario, Sonic), RPG (action-based role-playing games, Darkest Dungeon, Skyrim, Kingdom-come: Deliverance), Strategy (turn based or real time – Xcom, Civilization, Total Warhammer), Sports games (tennis, golf), Construction and management simulation (Minecraft), Social Simulation (Animal Crossing), Idle games (Cookie click, idle heros), and Other (open ended response where participants could write their own). Given that most video games overlap somewhat in their genres, we hereby differentiate action-oriented role-playing games and fantasy-based role-playing games by categorizing the former as “RPG”, as per popular usage (Rehbein et al., 2016), and the latter as “Social Simulation” to better emphasize differences between these two genres. We excluded responses entered in the “Other” video game genre question item as the responses were too few to reach statistical power.

The frequency of video game usage was quantified via participant self-evaluations on this questionnaire. There were five questions pertaining to video game usage. First, participants were asked on the following: 1) Self report usage: “What is your video game usage like?” on a 5-point Likert scale where 1 was “Very Often” and 5 was “Very rarely or not at all”, 2) Self report frequency: “How frequent do you play video games? Check one.” Participants had the option of selecting from “Daily”, “2 to 3 times a week”, “weekly”, “2 to 3 times a month”, “monthly”, “less than monthly”, and “never”, 3) Self report spare time: “What proportion of your spare time is spent on video games?” on a 5-point Likert scale where 1 was “Almost all of none of my spare time” and 5 “Almost all of my spare time”. For self-reported frequency, responses were scored as “1” if participants answered “Never” and “7” for “Daily”. Participants were also asked to enter the number of hours spent on video games for an average weekday and weekend day.

Experimental Procedures

Participants were first given the battery of questionnaires to complete, in the following order: Video Game Usage Questionnaire, AQ, and SPQ-BR. Afterwards, participants completed two computer tasks (1) Fitts Law Task to quantify targeting time, and (2) Simple Choice Task to quantify reaction time. Both computer tasks were administered via PsycToolKit.com (Stoet, 2010; Stoet, 2017), a toolkit for online cognitive-psychological experiments and surveys (www.psytoolkit.org/). The questionnaires were administered via SurveyMonkey (www.surveymonkey.com). The computer tasks are described below.

Fitts’ Law Task (20 Trials in total) (Fitts, 1954): There were 20 trials in total. On each trial, the participant was presented with a yellow square on the left upper side of a black screen. The participant was instructed to click on the yellow square with their mouse cursor. After the yellow square was clicked on, a red rectangle, of a randomized size, appeared on a random place on the screen. The participant was then instructed to move their mouse cursor to the red rectangle as quickly as possible, for a total of 20 times. When participant completed the Fitts’s Law Task, they were presented with a feedback screen that said: “Great job! Press the space bar to continue.” Then the participants were presented with a short summary of the task objectives: “Fitts’s Law. The time it takes you to move the cursor on the red rectangle depends on the size and the distance.

Press space bar to exit". After completion of the Fitts' Law Task, the participant moved onto the Simple Choice Task.

Simple Choice Task (8 Training Trials, 20 Experimental Trials) (Deary et al., 2011): For this task there were 28 trials in total, with 8 practice and 20 experimental trials. On each trial, a black cross appeared on a white square on the computer screen. Participants were instructed to press the space bar as soon as possible when they see a black cross appearing in the white box. The time when the cross appeared in the white box varied from trial to trial. No feedback on performance was given for either computer tasks.

Analysis

Analyses were conducted in R (v4.0.5) (R Core Team, 2021) using functions in the base statistical package. Linear regressions were conducted using the lm() function while logistic regressions were conducted using the glm() function with binomial response family. Stepwise elimination of independent variables, for stepwise regressions, was accomplished using the step() function. Two extreme outliers were removed from the reaction time analysis, due to them being over eight standard deviations from the other reaction time scores. To assess the relationship between the frequency of video game use and the thirteen AQ and SPQ subscales we conducted multiple regressions for each of the five measures of videogame use. We also conducted separate analyses of covariance (ANCOVAs) for each of these dependent variables, using each of the AQ and SPQ subscale scores as independent variables, and gender as a cofactor. To assess the relationship between the frequency of video game use and the composite, we conducted ANCOVAs as for the subscales and included interaction terms along with the gender cofactor. Correlations between reaction time and targeting score were assessed using a linear model analysis of covariance using the targeting score as the outcome variable and reaction time as independent variable, with gender as a covariate.

Effects of reaction time and targeting scores on each of the five measures of video game use were analyzed with ANCOVAs using each of the game use variables as an outcome and either reaction time or targeting score as the independent variable, and gender included as a covariate, and without an interaction term. To analyze the effects of the AQ and SPQ subscales, we performed backwards stepwise regressions starting with each all of the AQ and SPQ subscales and gender as independent variables for each of

the five use measure outcome variables. The least informative independent variable was iteratively dropped from the model until dropping a variable led to a less efficient model, as assessed using the Akaike information criterion.

Tests for association between reaction time, and targeting scores, on the type of games played were conducted using logistic regressions. Each of the game types was modelled with a separate analysis, with type of game played as a Boolean outcome; the independent variables were either reaction time, or targeting score, each of which also included gender as a covariate, without interaction terms. Tests for the association between reaction time and targeting scores and each of the different types of motivation to play games were conducted in the same manner, with one logistic regression of the motivational type as a Boolean outcome variable against either reaction time or targeting with gender included as a covariate.

To test for associations of AQ and SPQ scales with the type of games played, logistic regressions were conducted using general linear models with binomial response families. Each of the game types was modelled with a separate analysis, with type of game played as a Boolean outcome, and all subscales were entered as independent variables along with gender. No interaction terms were entered. A backwards stepwise method was used to successively drop the least informative independent variable, until dropping a variable led to a less efficient model, as assessed using the Akaike information criterion. Tests for association between the AQ and SPQ subscales and the motivations to play games were conducted in the same manner, with a separate stepwise elimination of subscales until reaching the most efficient model for each of the different motivation types. Simple bivariate analyses (e.g., t-tests, product-moment correlations) were conducted for some analyses, in addition to ANCOVAs and multiple regression analyses, for representation and depiction of the results for each relevant test, since these analyses make fewer assumptions.

2.4. Results

Gender differences in AQ, SPQ, and Patterns of Video Game Usage

Females scored higher than males on SPQ-Ideas of Reference, SPQ-Social Anxiety, SPQ-Magical Thinking, SPQ-Odd Speech, SPQ-Cognitive-Perceptual, SPQ-Disorganized, and SPQ-Total (Table 2.3 and Table 2.4). There were no outliers in the AQ-total or SPQ-total scores (Figure 2.2 and 2.3).

Males scored higher than females on all the variables that quantified video game usage (Tables 2.3 and 2.4). Males also demonstrated faster reaction and targeting time on the Simple Choice Task and Fitts' Law Task than females, respectively (Tables 2.3 and 2.4)

Females preferred Puzzle and Social Simulation games more than males did. By contrast, males preferred Action, RPG, Strategy, and Sports games (Tables 2.3 and 2.4). Males were more motivated by Social Interaction, Skill Development, Adrenaline Rush, and Fantasy reasons compared to females. No gender differences were detected for the motivations Stress Relief or Escape. Females were more motivated by Customization than males.

Patterns of video game use in relation to AQ-Total, SPQ-Total, and SPQ-CogPer

By product-moment correlations, higher AQ-total scores were significantly associated with higher video game use for the usage measures weekend hours, self-reported frequency, and self-reported usage, in females only (Table 2.1). Higher SPQ-CogPer scores were associated with reduced weekday and weekend hours, as well as decreased self-reported frequency and self-reported spare time spent on video games when both genders were pooled together. In females only, higher SPQ-CogPer score was also associated with decreased self-reported spare time video games usage. No statistically significant relationships were found for SPQ-Total. Higher AQ-Total scores were positively associated with higher self-reported frequency of video game usage in females, while male video game usage was relatively high across the entire range of AQ-Total scores (Figure 2.1).

Table 2.1 Pearson Correlations of AQ-total, SPQ-total, and SPQ-CogPer scores with Measures of Video Game Usage

Video Game Usage					
	Weekday time (h)	Weekend time (h)	Self report frequency	Self report usage	Self report spare time
Females (N = 207)					

AQ: Total	0.13	0.21**	0.17**	-0.20**	0.11
SPQ: CogPer	-0.05	-0.06	-0.12	-0.04	-0.17*
SPQ: Total	-0.02	0.05	-0.01	-0.10	-0.03
Males (N = 144)					
AQ: Total	-0.02	0.04	-0.03	0.07	0.05
SPQ: CogPer	-0.04	-0.03	-0.10	0.02	-0.04
SPQ: Total	0.03	0.06	-0.02	-0.10	0.11
Both Genders (N=351)					
AQ: Total	0.02	0.08	0.04	-0.06	0.04
SPQ: CogPer	-0.13**	-0.14**	-0.20***	0.06	-0.18***
SPQ: Total	-0.05	-0.02	-0.09	-0.04	-0.04

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001
Note that the scale for 'Self report usage' is directionally opposite to the other scales.

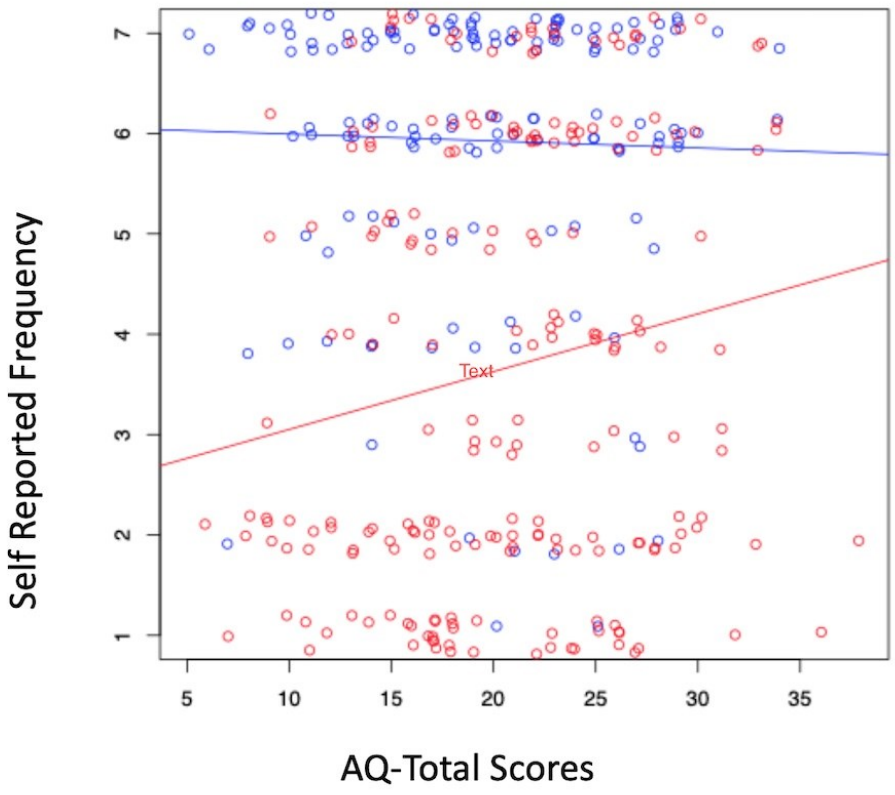

Figure 2.1 **Relationship between Self-reported Frequency and AQ scores for Females (red) and Males (blue)**

ANCOVAs revealed that higher AQ-total was associated with greater weekend time, higher self-reported frequency, and higher self-reported usage of video game usage with an interaction effect indicating that the effects were restricted to females (Table 2.5 and Figure 2.1). Higher scores on SPQ-CogPer were associated with lower self-reported frequency and lower self-reported spare time, with no gender interaction effect (Table 2.5).

Both forms of analyses showed that higher AQ-total scores were associated with greater weekend time, self-reported frequency, and self-reported usage, in females only. Higher scores on SPQ-CogPer were also associated with lower self-reported spare time in females only and in both genders pooled together. Higher scores on SPQ-CogPer were also associated with lower self-reported frequency scores in both genders together.

Patterns of video game use in relation to AQ and SPQ subscales

By product-moment correlations, in females only, scores on AQ-Attention to Detail were associated with greater weekday hours spent on video games (Table 2.6). AQ-total was not associated with any of the video game usage variables when males were analyzed separately or with the genders pooled together. In females only, AQ-Social Skills scores were positively associated with greater weekend time, self-reported frequency, and self-reported usage spent on video games. In females only, scores on AQ-Imagination scores were associated with greater weekend time and self-reported frequency spent on video games.

In females only, higher SPQ-Magical Thinking was associated with decreased self-reported spare time, while SPQ-Social Anxiety and SPQ-Disorganization were associated with greater weekend time on video games. In females only, SPQ-Eccentric Behaviour scores were also positively associated with greater weekend time and self-report spare time on video games, with the relationship marginally non-significant ($p=0.06$).

In males only, higher SPQ-Magical Thinking was associated with greater self-reported usage and spare time spent on video games. Higher SPQ-Eccentric Behaviour was associated with greater self-reported usage and spare time on video games. In males, higher SPQ-Disorganization was marginally non-significantly associated with greater

weekend time (p=0.06), and significantly associated with greater self-reported usage, and self-report spare time on video games.

When both genders were pooled together, higher SPQ-Magical Thinking was associated with decreased weekday, weekend, self-reported frequency, self-reported usage, and self-reported spare time on video games. Higher SPQ-Ideas of Reference scores were associated with decreased self-reported frequency on video games. Higher SPQ-Unusual Perception was associated with decreased weekday hours on video games. Higher SPQ-Eccentric Behaviour scores were associated with greater weekend time, self-reported usage, and self-reported spare time on video games.

By ANCOVAs, higher SPQ-Eccentric scores and SPQ-Magical Thinking were associated with higher and lower self-report spare time spent on video games, respectively (Table 2.7). The combined results from both analyses revealed that higher SPQ-Magical Thinking was associated with lower self-reported spare time spent on video games in females, in males, and in both genders combined. Higher SPQ-Eccentric was also associated with greater self-reported spare time spent on video games in males only, and in both genders combined.

Video game genre preferences in relation to AQ-Total, SPQ-Total and SPQ-CogPer scores

By t-tests, higher AQ scores were associated with increased preference for Construction type games and higher SPQ scores were associated with preferences for Social Simulation, when both genders were pooled together (Table 2.8). Higher AQ-total scores were also associated with decreased preference for Sports, and higher SPQ-total scores were also associated with preference for Puzzle and Racing. Higher SPQ-CogPer scores were associated with increased preference for Puzzle and Racing games, and decreased preferences for RPG and Construction type games.

When males were analyzed separately, higher AQ-total scores were associated with decreased preference for Platformer and Sport games. Higher SPQ-total and SPQ-CogPer scores were associated with increased preference for Racing games in males. When females were analyzed separately, higher AQ-total scores were associated with increased preference for RPG and Construction games. Higher SPQ-total and SPQ-CogPer scores were associated with increased preference for Puzzle games in females.

Backwards stepwise regression, conducted to test the effects of AQ-total, SPQ-total, and SPQ-CogPer on each video game genre while taking account of gender differences, showed that males reported higher preference for Action and Strategy games (Table 2.9). Preferences for Action and Strategy video games were not associated with AQ-total, SPQ-total, or SPQ-CogPer. Higher AQ-total scores were associated with preference for RPG and Construction games in females. Higher SPQ-CogPer scores and higher SPQ-Total were associated with higher preference for Puzzle games. Both sets of results indicated that females with higher AQ-total scores reported a higher preference for RPG and Construction games.

Video game genre preferences in relation to AQ and SPQ subscales

Preference for Puzzle games was associated with higher AQ-Imagination, higher SPQ-Eccentric Behaviours, and in females. Preference for Action games was associated with higher SPQ-Eccentric Behaviours in males (Table 2.9). Preference for Platformer was associated with higher SPQ-Eccentric Behaviours. Preference for RPG was associated with higher AQ-Social Skills, lower SPQ-Ideas of Reference, and higher SPQ-Eccentric, and in males. Preference for Strategy was associated with higher SPQ-Eccentric Behaviours and in males. Preference for Sports was associated with lower AQ-Communication and in males. Preference for Construction was associated with higher AQ-Social Skills, marginally with lower SPQ-Ideas of Reference, lower SPQ-Magical Thinking, and higher SPQ-Odd Speech. Preference for Social Simulation was detected in females, but no relationship to either AQ or SPQ subscales. Preference for Idle games was marginally associated with AQ-Attention Switch.

Video game motivations in relation to AQ-total, SPQ-total and SPQ-CogPer

By t-tests, females with higher AQ-Total scores were motivated by Stress Relief, Fantasy, and Customization (Table 2.10). Males with higher SPQ-CogPer scores were motivated by Stress Relief and Skill Development. Males with higher SPQ-total scores were motivated by Escape and Customization. Males with higher AQ-Total scores were more motivated to play video games for Customization.

When both genders were pooled together, higher AQ-Total scores were associated with motivations of Skill Development, Fantasy, Customization, and Stress Relief. Higher SPQ-Total scores were also associated with the motivation of Stress Relief.

By multiple regression analyses, Social Interaction was associated with decreased AQ-Social Skills, increased AQ-Attention to Detail, increased SPQ-Social Anxiety, and decreased SPQ-Magical Thinking (Table 2.11). Stress Relief was associated with increased AQ-Social Skills and increased SPQ-Unusual Perception. Skill Development was associated with increased AQ-Attention to Detail, increased SPQ-Idea of Reference, and increased SPQ-Social Anxiety. Adrenaline Rush was associated with lower AQ-Attention Switch, higher AQ-Attention to Detail, higher AQ-Communication, and higher AQ-Imagination. Escape was marginally associated with higher SPQ-Constricted Affect, higher SPQ-Eccentric Behaviour, and marginally associated with SPQ-Magical Thinking. Fantasy was associated with higher AQ-Social Skills and higher SPQ-Magical Thinking. Customization was associated with higher AQ-Attention to Detail and higher AQ-Communication. Higher AQ-Total was associated with greater motivations of Stress Relief, Fantasy, and marginally with Customization. No significant relationships were observed between SPQ-Total, SPQ-CogPer, and any of the motivations.

Reaction and targeting times in relation to AQ-Total, SPQ-Total, SPQ-CogPer, and gender

By product-moment correlations, in females only, faster reaction times were associated with higher AQ-Total and SPQ-Total scores (Table 2.12). There was also a marginally non-significant trend of association of higher AQ-Total scores with faster targeting time in females ($p=0.06$). No other statistically significant relationships were detected in males or in both genders pooled together.

Reaction and targeting times in relation to AQ and SPQ subscale scores, and gender

Faster reaction times were associated with higher SPQ-Eccentric Behaviour scores in both genders pooled together and in females. In females only, faster reaction times were associated with higher SPQ-Social Anxiety, SPQ-Disorganization AQ-Social Skills, and AQ-Attention to Detail. Higher SPQ-Magical Thinking scores were associated with slower reaction time in both genders pooled together and in males only (Table 2.12).

Higher AQ-Social Skills and SPQ-Social Anxiety scores were associated with faster targeting times in females. Higher SPQ-Magical Thinking scores were associated with

slower targeting times in both genders pooled together, in males, and in females. Higher SPQ-Unusual Perception scores were associated with slower targeting times in both genders pooled together. Faster targeting time associated SPQ-Interpersonal in males. Higher SPQ-CogPer scores were associated with slower targeting time in both genders and in males.

By multiple regression analyses, reaction times were significantly positively correlated with targeting times, with males being faster for both relative to females. No AQ or SPQ subscales were significantly associated with faster reaction times. Higher SPQ-Magical Thinking scores were associated with slower targeting times. These results are summarized in Table 2.13. By both forms of analyses, males exhibited faster reaction and targeting times than females, and higher SPQ-Magical Thinking was associated with slower targeting times.

Relationships of reaction and targeting times with video game usage, preferences and motivations

By product-moment correlations, faster targeting times were associated with increased self-reported spare time, weekend hours, weekday hours, greater self-reported video game usage and frequency in both genders pooled together, males only, and females only (Table 2.14). Faster reaction times were also associated with greater self-reported of spare time, weekend hours, weekday hours, greater self-reported usage, and greater self-reported frequency of video game usage in both genders pooled together and in males (Table 2.14).

By stepwise regression analyses, higher self-reported video game usage was associated with higher AQ-Attention to Detail, higher SPQ-Eccentric, faster targeting times, and being male. Higher self-report frequency of video game usage was associated with faster targeting times, and being male. Higher weekday time was marginally associated with higher AQ-Attention to Detail ($p= 0.058$), SPQ-Odd Speech, faster targeting times, and being male. Higher weekend time was marginally associated with AQ-Communication, SPQ-Odd speech, faster targeting times, and being male. Higher self-report spare time was associated with higher SPQ-Eccentric Behaviours, lower SPQ-Magical Thinking, faster targeting time, and being male. No statistically

significant relationships were detected for reaction times and any of the time use variables. Results are summarized in Table 2.15.

Relationships of reaction and targeting times with video game usage

ANCOVAs were also conducted to analyze the relationships of neurophysiological indices (i.e., reaction and targeting times) and the five video game usage variables. Gender was significantly associated with all usage variables (**Table 2.16).** In the case of self-reported frequency, males reported high baselines of video game use frequencies; a potential positive relationship between self-reported frequency and faster reaction time may have gone undetected due to a ceiling effect of general usage. In females, a strong positive relationship between self-reported video game use frequency and faster targeting times was detected.

Relationships of reaction and targeting times with video game genre preferences

By t-tests, faster reaction times were associated with preference for Action video games in both genders pooled together and marginally non-significantly in males (p=0.07) (Table 2.17). Faster reaction times were also associated with preference for RPG in both genders pooled together, in females, and in males. Strategy was also associated with faster reaction times in both genders pooled together and marginally non-significantly in females (p=0.06). Construction was associated with faster reaction times with both genders pooled together and in females. Idle game use was associated with faster reaction time in both genders and in males only.

Preferences for Action and Idle game genres was associated with faster targeting time in both genders pooled together, and in females. Preferences for Role Playing Games (RPG), Strategy Games, and Construction Games were associated with faster targeting time in both genders, in females, and in males. Preferences for Social Simulation were associated with faster targeting time in females and males when they were analyzed separately.

ANCOVA was also conducted to analyze the separate relationships of reaction times, targeting times, to each of the ten video game genres (Table 2.18). Faster reaction times were associated with preference for Action, RPG, Strategy in in males. Faster reaction times showed a marginal association with preference for Construction (p = 0.066).

Females reported greater preference for Puzzle and Social Simulation, but no significant relationships were found between reaction times and these two genres.

Faster targeting times were associated with preference for Action, RPG, Strategy, and Sports games in males. Faster targeting times were associated with preference for Construction and Idle, but no gender differences were detected. Females reported greater preference for Puzzle, but there were no significant differences in preference for Puzzle games and targeting times. Preference for Social Simulation were associated with faster targeting times in females. Results are presented in Table 2.18.

By both types of analyses, preference for Action, RPG, Strategy were associated with faster reaction and targeting times in males. Faster reaction and targeting times were associated with preference for Construction in both genders together. Preference for Social Simulation was associated with faster targeting times in females. Females reported greater preference for Puzzle but Puzzle was not associated with either faster reaction or targeting times.

Relationships of reaction and targeting times with video game motivations

By t-tests, faster reaction times were associated with the motivations Social Interaction, Skill Development, and Customization, in both genders pooled together and in males (Table 2.19). Faster targeting times were associated with Social Interaction, Stress Relief, Skill Development, Adrenaline Rush, Escape, Fantasy, and Customization in both genders pooled together, males only, and females only.

By logistic regression analyses, Social Interaction was marginally non-significantly ($p = 0.067$) associated with faster reaction time in males (Table 2.20). Skill Development was associated with faster reaction time in males. Males reported a greater preference for Adrenaline Rush, but no significant relationships were detected between Adrenaline Rush and faster reaction times. Customization was associated with faster reaction times. Social Interaction and Skill Development were associated with faster targeting time in males. Stress Relief was marginally non-significantly associated with faster targeting times ($p = 0.051$). Males reported greater preference for Adrenaline Rush, but no relationship were detected between Adrenaline Rush and targeting times. Fantasy and Customization were associated with faster targeting times.

By both types of analyses, Social Interaction and Skill Development were associated with faster reaction and targeting time in males. Customization was associated fasted with both faster targeting and reaction time. Stress Relief and Fantasy were associated with faster targeting times.

2.5. Discussion

The principal aims of this study were to investigate the relationships of autistic and schizotypal traits, gender, and select neurophysiological traits, with video game usage, preferences, and motivations. Table 2.2 summarizes the main results in the context of the predictions described in the Introduction. The most important findings are three-fold. First, our results are largely consistent with prior findings that differences in patterns of video game usage mirror gender differences in childhood play, with some notable differences in females with higher autistic traits. Second, we have observed a male-typical pattern of video game usage, motivation, and genre preferences in females with higher autistic traits, which is in support of the Extreme Male Theory of autism (Baron-Cohen, 2002). Third, results partially support of the Crespi and Badcock (2008) diametrical model of social brain disorders, in that some video game variables show opposite patterns between autism and positive schizotypy. Finally, we expand on each main result in turn, and then discuss the evolutionary psychological implications of virtual play on human social behaviours.

Table 2.2 Study findings in relation to the main predictions

Predictions	Supported?	Findings
(1.1) Males will report greater video game usage than females.	Yes	Males reported higher video game usage across all time use variables.
(1.2) Males will prefer mechanistic-oriented video games (Action, Platformer, Strategy, Racing, Sports, RPG, Construction) while females will prefer Puzzle and Social Simulation video games.	Partially	Males reported greater preference for Action, Strategy, Sports, and RPG games. Females reported greater preference for Puzzle and Social Simulation games.
(1.3) Males will report greater motivation of Skill	Partially	Males reported greater motivations of Social Interaction and Skill Development. Females with

Development and Customization and females will report greater motivations of Social Interaction, Fantasy, and a way to Escape.		higher AQ reported greater motivations of Fantasy, Stress Relief, and Customization.
(2): Autistic traits will be associated with increased video game usage across all time use variables. SPQ-total and SPQ-CogPer will be associated with decreased video game usage across all time use variables.	Partially	Higher autistic traits were associated with greater video game usage in females. Higher SPQ-CogPer scores were associated with lower video game usage in both sexes pooled together Higher autistic traits were not associated with greater video game usage in males.
(3): Autistic traits will be positively associated with preferences for Puzzle, Action, Platformer, Strategy, Racing, Sports, Idle, and Construction. SPQ-total and SPQ-CogPer will be positively associated with preferences for fantasy, RPG, and social simulation video games.	Partially	Females with higher AQ-Total preferred Construction and RPG games. Higher SPQ-Cog-Per scores and higher SPQ-Total scores were associated with greater preference for Puzzle games.
(4): Autistic traits will be positively associated with greater mechanistic motivations. SPQ-Total and SPQ-CogPer will be positively associated with mentalistic motivations.	Partially	Higher AQ-Total was associated with greater motivations of Stress Relief, Fantasy, and Customization. No associations were found for SPQ-Total or SPQ-CogPer.
(5): Autistic traits will be associated with faster reaction time and targeting time. SPQ-Total and SPQ-CogPer will be associated with slower reaction and targeting times.	Partially.	Higher SPQ-Magical Thinking was associated with slower targeting times.
(6): Increased total video game usage will be predicted by higher reaction and targeting time. In turn, slower reaction and hand-eye	Yes	Faster reaction and targeting times were associated with greater video game usage.

coordination time will predict lower video game usage.

Gender Differences in Patterns of Video Game Usage: First, differences in video game usage patterns, genre preferences, and motivations are largely consistent with prior findings that males played more video games than females (Greenberg et al., 2010), preferred action type video games (Greenberg et al., 2010), and exhibited both faster reaction times (Greenberg et al., 2010) and enhanced targeting abilities (Watson and Kimura, 1991; Cook and Saucier, 2010). Females reported greater gaming motives of Customization; by contrast, Hartmann and Klimmt (2006) found that females generally enjoy video games for their socially interactive aspects.

Why do males play video games more than females? One possibility may be that most video games are designed to simulate male-male individual or coalitional competition (Mendenhall et al., 2010), which are intrinsically rewarding and enjoyable to males (Chou and Tasi, 2007; Olson et al., 2007). For example, most first-person shooter (FPS) video games, such as Call of Duty, involve playing from the first-person view of a soldier. FPS gameplay mostly involves three main themes: 1) mastering the deployment of various weapons to destroy targets and enemies, 2) collaborating with other soldiers to accomplish missions, 3) rising through status hierarchies via achieving goals or collecting rewards and gear. In line with our results, previous studies on first-person shooter games have identified that they are mostly played by young males, who spend an average of 2.6 hours a day on gaming, and report social interaction, competition, and challenge as their main motives for gaming (Jansz, and Tanis, 2007). Likewise, MMORPGs, such as World of Warcraft (reported to consist of 85% of male user-base (Ducheneaut et al., 2006) are designed to promote inter-factional warfare, the collection of rare and conspicuous avatar equipment (i.e., status signalling) and collaborative practices that simulate conditions of hunting (Mendenhall et al., 2010). Altogether, the greater representation of male video game players appears to reflect the male-typical competitive environments of most video game genres, which seek to recreate or simulate settings of cooperative hunting and warfare.

The findings reported here are also consistent with prior research indicating that females prefer classic puzzle or board games (Greenberg et al., 2010) and life simulation games

(Nepomuceno et al. 2010; Yee, 2017), the latter of which tends to be more exploratory in nature and with a greater emphasis on social relationships than competition. Interestingly, although females generally reported a preference for Social Simulation games, they did not cite Social Interaction as a motivation for using video games. Contrary to the hypothesis posited here, females reported Customization as their primary motivation. Two possibilities may be at play here. First, given that females with higher autistic traits play more video games (as discussed in more detail below), the female pattern of video game motivation may reflect the higher mechanistic (i.e., non-social) preferences of the autistic phenotype. That is, given that autistic traits have been associated with greater preference for building activities and solitary play (Holmes and Willoughby, 2005), the identification of Customization, rather than Social Interaction, as the main gaming motive, may reflect the systemizing bias of autism. Secondly, given that females are more likely to be casual video game players than are males, and casual video game players tend to rank higher on extraversion (Potard et al., 2019), females (at least ones with lower AQ scores) may have other social outlets for meeting interpersonal needs outside video games, and thus be less likely to identify Social Motivation as a main motive for video game usage.

Females with higher levels of autistic traits also preferred male-typical video game preferences, including RPG and Construction, relative to general female-typical genre preferences such as Puzzle and Social Simulation. A preference for Construction type games was not detected among males, although previous studies have documented male preferences for constructive toys (Blakemore and Centers, 2005). As for males with higher AQ, females with higher AQ also identified the mechanistic preference Customization as one of their main gaming motives.

Extreme Male Brain Theory of Autism and Patterns of Video Game Usage: Our second hypothesis predicted that autistic traits will be associated with increased video game usage. Interestingly, higher autistic traits were associated with greater video game usage, but only in females and not in males.

The pattern of females with higher total autism scores playing video games more frequently is of notable interest, as it fits with Baron-Cohen's (2002) extreme male brain theory of autism, and partially with the predictions from Wendt et al. (2019) and Crespi and Badcock (2008). Thus, females with higher AQ-total scores were “more male” in

their pattern of higher video game usage. Analysis of the AQ subscale revealed that that decreased social skills, higher attention to detail, and lower social imagination showed evidence of being related to greater video game usage in females with higher autistic traits. Taken together, the cluster of autistic traits outlined above suggest that higher video game usage in females may be attributable to a more systemizing cognitive style (Baron-Cohen, 2010). Indeed, the association between higher autistic traits in females and greater motives of Customization and preference for Construction-type games is consistent with such view. For example, one popular Construction game, Minecraft, focuses predominately on the mechanistic drive of building objects. As the virtual environment is literally made of pixelated blocks, gameplay is centered around manipulating objects in systematic ways to construct buildings, mazes, and even entire cities. Paralleling play behaviours in children with autism, building activities in Minecraft are usually solitary, detail-oriented, and reality-based. For example, “making” a book in Minecraft, as with real life, requires arranging virtual pieces of paper with virtual leather in a particular order for the object to be realized. Given that people with autism are disproportionately represented in the engineering field (Baron-Cohen et al., 1997; Baron-Cohen, 1998) and children with autism tend to focus on functional play (i.e., play with an object for its function) and constructive play (i.e., building sand castles), preference for parallel (i.e., playing alongside others but not together) or solitary play (Holmes and Willoughby, 2005), the patterns of video game usage described above appear to be an extension of autistic play behaviours to in a virtual, computerized medium.

Females with higher total autism scores also reported greater gaming motivations of Stress Relief, Fantasy, and Customization; the first two motivations may be categorized under social fulfillment via virtual play, and the latter may represent an autism-related preference for rule-based, solitary mechanistic interest such as building (e.g. Minecraft). Taken together, these patterns suggest that higher autistic traits may be related to greater video game usage via a decreased capacity for, or interest in, social and pretend play. In other words, because most video games environments involve pre-programmed characters, narratives, and behaviours, they may appeal to individuals with higher autistic traits who prefer predictable environments that can be navigated with pre-defined action patterns. In this light, video games may also function specifically for their self-contained immersive experiences that provide the illusion of sharing a social world without partaking in one. The relative anonymity and use of virtual avatars in video

games offers an additional layer of interpersonal distance that can be conceptualized as the virtual extensions of parallel play behaviors commonly observed in children with autism (Holmes and Willoughby, 2005). Users are thus playing “together” but remain alone. Moreover, the results above can be differentiated from general play differences in two important ways: (1) although females with higher autistic traits report male-typical preferences such as RPG and Customization, they do not share the other male-typical preferences that were more socially collaborative in nature, such as Sports, or Action and Strategy genres that involve extensive teamwork (e.g. military group-collaborations in Call of Duty); and (2) the identification of Fantasy as a motivation was not associated with the concurrent motivation of Social Interaction, which suggest that solitary play was the common denominator described here.

Why was there no evidence of a positive correlation of AQ score with video game use among males?

One possibility is a 'ceiling effect', whereby males would exhibit too little variation in video game use scores for a positive relationship to be detected. However, males do exhibit comparable levels of variability (as measured by standard deviations) to females across the various measures of video game usage, and positive correlations restricted to females were found for multiple video game use frequency measures, which appears to render major influences from ceiling effects relatively unlikely. Alternatively, because most video games are designed with male-typical preferences such as competition (Jansz, and Tanis, 2007) and physical violence (Jansz, 2005), and females are more likely to prefer non-violent entertainment ventures (Slater, 2003) and may be less competitive than males (Deaner, 2013), video game usage among females with higher total AQ scores may be more pronounced, compared to males, with high-AQ females demonstrating more male-typical cognitive phenotypes relative to the general female population.

The Diametrical Model of Social Brain Disorders and Patterns of Video Game Usage: Our second hypothesis also predicted that patterns of video game usage would vary in opposite patterns along the autism-schizotypal axis, with autistic traits associated with greater video game usage and positive schizotypal traits (i.e., SPQ-total and SPQ-CogPer) with lower video game usage.

Evidence of negative relationships of SPQ-CogPer and SPQ-Magical Thinking with video game usage was detected from several analyses. These findings partially support predictions of the Crespi-Badcock model, in that autistic and positive schizotypy traits predicted greater and lower video game usage, respectively (though with gender-limited effects for autism that were not predicted by the model). Given that SPQ-Magical Thinking was also associated with slower targeting times, lower video game usage of individuals with high levels of this psychological trait may stem, in part, from general hand-eye motor speed and coordination difficulties from executing particular action patterns necessary for effective console/controller use. Indeed, a positive relationship was detected between SPQ-CogPer and Puzzle games, but Puzzle was not associated with faster reaction or targeting times. Furthermore, although both Puzzle and Social Simulation games are generally designed to be played at leisure, the latter was associated with faster targeting times but not the former, further providing support that variation in neurophysiological indices may be contributing to the overall lower video game usage.

Why would individuals higher in positive schizotypal traits play video games less frequently? As outlined above, most video games appear to offer immersive but ultimately solitary play experiences that may not fulfill the mentalistic interests of many schizotypal individuals. Historically, most video games were developed as single-player ventures; lack of historical internet access meant that most games were developed to be enjoyed with only a limited number of players. For examples, the popularity of PC-based games in the 1990s meant that most games were designed to be self-contained, with clearly defined objectives, and catering to single players. In this light, given that the Crespi and Badcock (2008) model predicts that autistic and schizotypal traits would vary in opposite directions in socio-cognitive development – what would be the theoretical equivalent of autism and videogames for positive schizotypy?

An opposite medium (as opposed to different games per se) would theoretically contain the following characteristics of high positive schizotypy: 1) rely on a short and fractured attention span on a wide variety of inter-changeable topics instead of one highly concentrated focus on a restricted set of clearly defined objectives, 2) verbally based, 3) high social connectivity, 4) virtual elements of high social monitoring in terms of detectable social feedback signals (i.e., likes, followers) that mimic in-person cues of joint attention and/or eye contact. In short, the logical equivalent of autism-video games

appears to be schizotypy-Twitter or TikTok. Although we did not explicitly test for the relationship between schizotypy and social media platforms here, the association between positive schizotypy and Puzzle games suggest that such preferences could theoretically be extrapolated to social media platforms. Like most Puzzle games, most social media applications are designed to be used leisurely, with less cognitively taxing actions, and with no penalties if the user has less than accurate targeting movements.

Several explanations have been proposed for gender differences in reaction and targeting time. First, given that playing action video games can improve reaction time (Chandra et al., 2016), the gender differences may stem from the strong male preference toward action-oriented video games that require fast decision-making and projectile analysis in a simulated 3-D space. Our data support the training effect of video game usage in that in both genders, reaction and targeting times are positively associated with greater video game usage. Second, males also reported greater motivation for using video games for Skill Development, another factor that could contribute to the development of faster reaction and targeting time due to greater intrinsic motivation for improvement. Alternatively, the gender differences in reaction and targeting time may stem from evolved physiology in sexual divisions of labour; that is, males may have evolved faster reaction and targeting times than females due to greater neurophysiological demands of hunting and competition that have characterized the human hunter-gatherer past (Cherney and Poss, 2008). Finally, given that SPQ-Magical Thinking was associated with slower targeting times and that females scored higher on SPQ-Magical Thinking than did males, the gender differences in targeting time may be linked with general gender differences in levels of this schizotypal trait. Indeed, the association of higher Magical Thinking with slower targeting time is consistent with previous literature showing that higher positive schizotypy is associated with higher prediction error rates on hand-eye coordination tasks (Asai et al., 2008) and increased dyscontrol in fine motor movements (Roché et al., 2015). These findings may, more generally, reflect the higher levels of sensory and sensorimotor deficits found among individuals on the schizophrenia spectrum (Javitt and Freedman, 2015).

Second, in accordance with the Crespi and Badcock model (2008), autistic traits were generally associated with mechanistic genre preferences such as Construction and RPG. However, contrary to the predictions made here, higher SPQ-CogPer scores and higher SPQ-Total scores were associated with greater preference for Puzzle games.

Theoretically, puzzle games could be considered a mechanistic-typical genre as most traditional puzzles involve deducing or reverse-engineering a set of given patterns to arrive at the correct solution. What would explain this finding? One possibility is that most virtualized puzzle games do not involve the same depth or rigor of algorithmic thinking as it would in traditionally puzzles. For example, one of the most popular app-based puzzle games, Candy Crush, involve detecting a pattern of three or more identical shapes and swiping them away with ones' fingers; gameplay is largely easy and simple pattern-detection in a 2-D space. In contrast, a traditional puzzle game might be solving the Magic Cube, a task that involves simultaneous operations of 3-D mental rotation, mathematical operations, and mental simulation of object transformations in horizontal/vertical space. Thus, although both physical and virtual "puzzle" games may appear similar, the constraints of representing games in a virtual 2-D space may remove or imbue it with different functions that may render it considerably different from its original counterpart.

The association of positive schizotypal traits with Puzzle type games is consistent with previous findings that patients with schizophrenia rated puzzle-type games as one of their top three preferred game genres (i.e., board/card games) (Choi et al., 2020). Surprisingly, contrary to the predictions made here, positive schizotypal traits were not related to more socially oriented or fantasy-based genres such as RPG or Social Simulation. Two possible explanations may help to account for this result. First, most popular role-playing video game games, such as World of Warcraft, are cognitively demanding and involve juggling of multiple simultaneous tasks (i.e., switching between weapons, building and maintaining multiple coalitions, tracking and shooting at multiple targets), which may be challenging given that schizotypy has been associated with attentional impairments under situations of high perceptual load (Stotesbury et al., 2018). In comparison, Puzzle-type games, such as Candy Crush, tend to less time-intensive, more casual, and designed to be played at leisure with no penalties if the user stops at random intervals. Second, the most popular current Social Simulation franchise, such as Animal Crossing, involve considerable components of customization (e.g., building and furnishing houses, gathering, and collecting items) which may be more mechanistically inclined and less appealing to individuals with higher schizotypal traits.

Lastly, patterns of video game motivations described here partially support the Crespi and Badcock (2008) model that autistic traits predict mechanistic motivations for playing

video games (i.e., Customization). Interestingly, AQ-total was also associated with Fantasy, but not Social Interaction, motivations. The pattern described here is suggestive that video games provide an evolutionarily novel play environment where fantasy play can be decoupled from social interactions. In other words, although autistic traits were associated with motivations for utilizing video games for Stress Relief and Fantasy motives, it was not associated with motivations for socially interacting with others, which suggests that although, on the surface, most role-playing games involve multiplayer modes and opportunities for social interactions, individuals with autistic traits seem to partake in them for the immersive experience but not the social aspect. Thus, utilizing video games for fantasy play appears to differ from real-life fantasy play in the important aspect that the imaginative component could be dissociated from its corresponding social component, which are intricately linked together most real-life, in-person childhood pretend play.

Limitations: Our study is constrained by several limitations. First, the data were collected during a school semester; thus, general video game usage patterns may have been under-reported due to greater time demands of the typical school semester. Future studies may account for potential differences in video game usage patterns due to classwork demands by incorporating a non-typical school semester in its time span of data collection for comparison. Second, given that we primarily recruited through a psychology student pool as well as university email lists, most of participants may have come from the undergraduate population; thus, the findings cannot be extrapolated to clinical populations, children, the elderly, or professional gamers who may demonstrate psychological traits atypical of our sample. Third, given that autistic and schizotypal traits were assessed via self-reports, results may be limited in that higher autistic and schizotypal may, paradoxically, be associated with lower cognitive insights and thus under-report of traits. Fourth, given the heterogeneous nature of most video games (e.g.: Legend of Zelda is classified as Action on most commercial video game websites, but it also involves considerable role-playing and puzzle-solving), findings from this study may be limited due to blending of mechanistic vs. mentalistic gameplay that characterize some video games. Future research could address such limitations by adding an open-feedback answer item as to better disentangle nuances in users' motivations for gaming and gaming preferences.

Finally, given that we administered reaction time and targeting time tasks online, variability in reaction and targeting time data may be confounded by participants' choice of electronic device to complete the tasks (e.g. computer with mouse, laptop, iPad or another hand-held device with touchpad). Although the computer tasks were designed to accommodate a wide variety of electronic devices, variability in reaction time and targeting time data may be influenced by participants' use of a mouse versus touchpad, which we did not control for. Some studies have shown that individuals were slower and tend to make more errors when using a touchpad than mouse to make pointing actions (Hertzum and Hornbæk, 2010), and that using the mouse was faster than touchpads or MultiTouch devices in cursor positioning (Shanis and Hedge, 2003). Given that our study was conducted remotely and thus we could not verify what sort of hardware participants used, future research could collect data on the type of device used to control for any potential confounds.

Since the COVID pandemic began, more and more recreational platforms have been moving to the virtual world. What will become of iGen 2030? The patterns described above suggest that the replacement of in-person play with virtual media may have important implications for the evolution of imaginative culture. First, the patterns in autistic play behaviours and video game usage described in this study suggest that video games may be a proverbial "new and reinvented" version of fantasy play. That is, unlike a traditional fantasy game where people must spontaneously imagine a shared mental space and participate accordingly, video games offer a pre-programmed imaginative space where anyone can join without having to spontaneously imagine entities into existence. Moreover, for the first time in human history, people are no longer bounded by the temporal-spatial limitations of other players to start and maintain a game. Almost everyone now can play a video game together – and alone.

Finally, although we have found some evidence of decreased video game usage in association with positive schizotypy, we did not observe statistically significant patterns for greater mentalistic preferences in positive schizotypy as we did for mechanism and autism. Why would this be? One possibility is that video games only represent one end of the spectrum of virtual play behaviors that has now substituted for much of real-life play. The patterns of video game usage, preferences, and motivations described above suggest that imaginative and social aspects could be dissociated in video games; individuals with higher autistic traits appear to partake more in the former in lieu of the

latter. In this light, as Crespi and Badcock (2008) postulated autism and psychosis as two ends of a continuum of social cognitive development, so there may exist a similar virtual gradient of play behaviours that may be expressed in two opposites but related media. What could be on the other end of the spectrum? Given that most social media platforms are highly socially oriented, verbally based, and performative, future studies could investigate potential relationships of social media use and positive schizotypy given the former's mentalistic bias.

2.6. References

Andreasen, N. C., Arndt, S., Del Miller, D., Flaum, M., and Napoulos, P. (1995). Correlational studies of the Scale for the Assessment of Negative Symptoms and the Scale for the Assessment of Positive Symptoms: an overview and update. Psychopathology, 28, 7-17. doi:10.1159/000284894

Asai, T., Sugimori, E., and Tanno, Y. (2008). Schizotypal personality traits and prediction of one's own movements in motor control: What causes an abnormal sense of agency?. Conscious Cogn. 17, 1131-1142. doi:10.1016/j.concog.2008.04.004

Baron-Cohen, S. (1998). Does autism occur more often in families of physicists, engineers, and mathematicians?. Autism, 2, 296-301. doi:10.1177/1362361398023008

Baron-Cohen, S. (2002). The extreme male brain theory of autism. Trends Cogn. Sci. 6, 248-254. Doi:10.1016/S1364-6613(02)01904-6

Baron-Cohen, S. (2010). Empathizing, systemizing, and the extreme male brain theory of autism. Prog. Brain Res. 186, 167-175. doi:10.1016/B978-0-444-53630-3.00011-7

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., and Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 364, 1377-1383. doi:10.1098/rstb.2008.0337

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., and Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. Rev. J. Autism Dev. Disord. 31, 5-17. doi:10.1023/A:1005653411471

Baron-Cohen, S., Wheelwright, S., Stott, C., Bolton, P., and Goodyer, I. (1997). Is there a link between engineering and autism?. Autism, 1(1), 101-109. doi:10.1177/1362361397011010

Bateson, P. (2005). "The role of play in the evolution of great apes and humans," in The Nature of Play: Great Apes and Humans, ed. A. D. Pellegrini and P. K. Smith (New York, NY: the Guildford Press.), 13-24.

Bekoff, M. (2001). Social play behaviour. Cooperation, fairness, trust, and the evolution of morality. J. Conscious. Stud. 8, 81-90.

Blakemore, J. E. O., and Centers, R. E. (2005). Characteristics of boys' and girls' toys. Sex roles. 53, 619-633. doi:10.1007/s11199-005-7729-0

Burghardt, G. M. (2005). The genesis of animal play: Testing the limits. Cambridge: MIT press.

Cadenhead, K. S., Light, G. A., Geyer, M. A., and Braff, D. L. (2000). Sensory gating deficits assessed by the P50 event-related potential in subjects with schizotypal personality disorder. Am. J. Psychiatry. 157, 55-59. doi:10.1176/ajp.157.1.55

Casey, B. J., Gordon, C. T., Mannheim, G. B., and Rumsey, J. M. (1993). Dysfunctional attention in autistic savants. J. Clin. Exp. Neuropsychol. 15, 933-946. doi:10.1080/01688639308402609

Chandra, S., Sharma, G., Salam, A. A., Jha, D., and Mittal, A. P. (2016). Playing action video games a key to cognitive enhancement. Procedia Comput. Sci. 84, 115-122. doi:10.1016/j.procs.2016.04.074

Cherney, I. D., and Poss, J. L. (2008). Sex differences in Nintendo Wii™ performance as expected from hunter-gatherer selection. Psychol. Rep. 102, 745-754. doi:10.2466/pr0.102.3.745-754

Choi, W. T., Dan, K. S., Wong, T., Lantta, T., Yang, M., and Välimäki, M. (2020). Habits and Attitudes of Video Gaming and Information Technology Use in People with Schizophrenia: Cross-Sectional Survey. J. Med. Internet Res. 22, e14865. doi:10.2196/14865

Chou, C., and Tsai, M.J. (2007) Gender differences in Taiwan high school students' computer game playing. J. Med. Internet Res. 23, 812–824. doi:10.1016/j.chb.2004.11.011

Cohen, A. S., Matthews, R. A., Najolia, G. M., and Brown, L. A. (2010). Toward a more psychometrically sound brief measure of schizotypal traits: introducing the SPQ-Brief Revised. J. Pers. Disord. 24, 516-537. doi:10.1521/pedi.2010.24.4.516

Colquitt, J. A., and Simmering, M. J. (1998). Conscientiousness, goal orientation, and motivation to learn during the learning process: A longitudinal study. J. Appl. Psychol. 8, 654. doi:10.1037/0021-9010.83.4.654

Cook, C. M., and Saucier, D. M. (2010). Mental rotation, targeting ability and Baron-Cohen's empathizing–systemizing theory of sex differences. Pers. Individ. Dif. 49, 712-716. doi:10.1016/j.paid.2010.06.010

Coutelle, R., Weiner, L., Paasche, C., Pottelette, J., Bertschy, G., Schröder, C. M., and Lalanne, L. (2021). Autism Spectrum Disorder and Video Games: Restricted Interests or Addiction?. Int. J. Ment. Health. Addict. 1-22. doi:10.1007/s11469-021-00511-4

Craig, F., Tenuta, F., De Giacomo, A., Trabacca, A., and Costabile, A. (2021). A systematic review of problematic video-game use in people with Autism Spectrum Disorders. Res. Autism Spectr. Disord. 82, 101726. doi:10.1016/j.rasd.2021.101726

Crespi B.J. (2016) The Evolutionary Etiologies of Autism Spectrum and Psychotic Affective Spectrum Disorders. In: Alvergne A., Jenkinson C., Faurie C. (eds) Evolutionary Thinking in Medicine. Advances in the Evolutionary Analysis of Human Behaviour. Springer, Cham. doi:10.1007/978-3-319-29716-3_20

Crespi, B. (2020). How is quantification of social deficits useful for studying autism and schizophrenia?. Psychol. Med. 50, 523-525. doi:10.1017/S0033291719003180

Crespi, B. J. (2019). Comparative psychopharmacology of autism and psychotic-affective disorders suggests new targets for treatment. Evol. Med. Public Health. 2019, 149-168. doi:10.1093/emph/eoz022

Crespi, B. J., and Go, M. C. (2015). Diametrical diseases reflect evolutionary-genetic tradeoffs: evidence from psychiatry, neurology, rheumatology, oncology and immunology. Evol. Med. Public Health, 216-253. doi:10.1093/emph/eov021

Crespi, B., and Badcock, C. (2008). Psychosis and autism as diametrical disorders of the social brain. Behav. Brain. Sci. 3, 241-261. doi:10.1017/S0140525X08004214

Crespi, B., Leach, E., Dinsdale, N., Mokkonen, M., and Hurd, P. (2016). Imagination in human social cognition, autism, and psychotic-affective conditions. Cognition, 150, 181-199. doi:10.1016/j.cognition.2016.02.001

Deaner, R. O. (2013). Distance running as an ideal domain for showing a sex difference in competitiveness. Arch. Sex Behav. 42, 413-428. doi:10.1007/s10508-012-9965-z

Deary, I. J., Liewald, D., and Nissan, J. (2011). A free, easy-to-use, computer-based simple and four-choice reaction time programme: the Deary-Liewald reaction time task. Behav. Res. Methods. 43, 258-268. doi:10.3758/s13428-010-0024-1

Deleuze, J., Christiaens, M., Nuyens, F., and Billieux, J. (2017). Shoot at first sight! First person shooter players display reduced reaction time and compromised inhibitory control in comparison to other video game players. Comput. Human. Behav. 72, 570-576. doi:10.1016/j.chb.2017.02.027

Delhove, M., and Greitemeyer, T. (2020). The relationship between video game character preferences and aggressive and prosocial personality traits. Psychol. Pop. Media Cult. 9, 96. doi:10.1037/ppm0000211

Dorval, M., and Pepin, M. (1986). Effect of playing a video game on a measure of spatial visualization. Percept. Mot. Skills. 62, 159-162. doi:10.2466/pms.1986.62.1.159

Ducheneaut, N., Yee, N., Nickell, E., and Moore, R. J. (2006). Building an MMO with mass appeal: A look at gameplay in World of Warcraft. Games Cult. 1, 281-317. doi:10.1177/1555412006292613

Dye, M. W., Green, C. S., and Bavelier, D. (2009). Increasing speed of processing with action video games. Curr. Dir. Psychol. Sci. 18, 321-326. doi:10.1111/j.1467-8721.2009.01660.x

Entertainment Software Association. (2019). ESA Essential Facts 2019. From www.theesa.com/wp-content/uploads/2019/05/ESA_Essential_facts_2019_final.pdf. [Accessed August 6, 2021].

Entertainment Software Association. (2021) Industry facts. From http://www.theesa.com/facts/index. [Accessed August 6, 2021].

Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. J. Exp. Psychol. 47, 381. doi:10.1037/h0055392

Gorbet, D. J., and Sergio, L. E. (2018). Move faster, think later: Women who play action video games have quicker visually-guided responses with later onset visuomotor-related brain activity. PloS One, 13, e0189110. doi:10.1371/journal.pone.0189110

Green, C. S., and Bavelier, D. (2006). Enumeration versus multiple object tracking: The case of action video game players. Cognition, 101, 217-245. doi: 10.1016/j.cognition.2005.10.004

Green, C. S., Pouget, A., and Bavelier, D. (2010). Improved probabilistic inference as a general learning mechanism with action video games. Curr. Biol. 20. 1573-1579. doi:10.1016/j.cub.2010.07.040

Greenberg, B. S., Sherry, J., Lachlan, K., Lucas, K., and Holmstrom, A. (2010). Orientations to video games among gender and age groups. Simul. Gaming. 41, 238-259. doi:10.1177/1046878108319930

Griffith, J. L., Voloschin, P., Gibb, G. D., and Bailey, J. R. (1983). Differences in eye-hand motor coordination of video-game users and non-users. Percept. Mot. Skills. 57, 155-158. doi:10.2466/pms.1983.57.1.155

Hartmann, T., and Klimmt, C. (2006). Gender and computer games: Exploring females' dislikes. J. Comput. Mediat. Commun. 11, 910-931. doi:10.1111/j.1083-6101.2006.00301.x

Hertzum, M. and Hornbæk, K. (2010). How age affects pointing with mouse and touchpad: A comparison of young, adult, and elderly users. Int. J. Hum. Comput. Interact. 26, 703-734. doi:10.1080/10447318.2010.487198

Hilgard, J., Engelhardt, C. R., and Bartholow, B. D. (2013). Individual differences in motives, preferences, and pathology in video games: the gaming attitudes, motives, and experiences scales (GAMES). Front. Psychol. 4, 608. doi:10.3389/fpsyg.2013.00608

Holmes, E., and Willoughby, T. (2005). Play behaviour of children with autism spectrum disorders. J. Intellect. Dev. Disabil. 30, 156-164. doi:10.1080/13668250500204034

Hubert-Wallander, B., Green, C. S., and Bavelier, D. (2011). Stretching the limits of visual attention: the case of action video games. Wiley Interdiscip. Rev. Cogn. Sci. 2, 222-230. doi:10.1002/wcs.116

Jansz, J. (2005). The emotional appeal of violent video games for adolescent males. Commun. Theory. 15, 219-241. doi:10.1111/j.1468-2885.2005.tb00334.x

Jansz, J., and Tanis, M. (2007). Appeal of playing online first person shooter games. Cyberpsychol. Behav. 10, 133-136. doi:10.1089/cpb.2006.9981

Javitt, D.C. and Freedman, R. (2015). Sensory processing dysfunction in the personal experience and neuronal machinery of schizophrenia. Am. J. Psychiatry. 172, 17-31. doi:10.1176/appi.ajp.2014.13121691

Johnson, D., and Gardner, J. (2010). Personality, motivation and video games. In Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction. 276-279. doi:10.1145/1952222.1952281

Kowal, M., Toth, A. J., Exton, C., and Campbell, M. J. (2018). Different cognitive abilities displayed by action video gamers and non-gamers. Comput. Human. Behav. 88, 255-262. doi:10.1016/j.chb.2018.07.010

Kuo, M. H., Orsmond, G. I., Coster, W. J., and Cohn, E. S. (2014). Media use among adolescents with autism spectrum disorder. Autism, 18(8), 914-923. doi:10.1177/1362361313497832

Lenzenweger, M. F. (2001). Reaction time slowing during high-load, sustained-attention task performance in relation to psychometrically identified schizotypy. J. Abnorm. Psychol. 110, 290. doi:10.1037/0021-843X.110.2.290

Lenzenweger, M. F., and O'Driscoll, G. A. (2006). Smooth pursuit eye movement and schizotypy in the community. J. Abnorm. Psychol. 115, 779. doi:10.1037/0021-843X.115.4.779

Lenzenweger, M. F., Cornblatt, B. A., and Putnick, M. (1991). Schizotypy and sustained attention. J. Abnorm. Psychol. 100, 84. doi:10.1037/0021-843X.100.1.84

Leslie, A. M. (1987). Pretense and representation: The origins of "theory of mind." *Psychological Review, 94*(4), 412–426. doi:10.1037/0033-295X.94.4.412

Leslie, A. M. (1987). Pretense and representation: The origins of" theory of mind." Psychol. Rev. 94, 412. doi:10.1037/0033-295X.94.4.412

Li, X., Huang, L., Li, B., Wang, H., and Han, C. (2020). Time for a true display of skill: Top players in league of legends have better executive control. Acta Psychol. 204, 103007. doi:10.1016/j.actpsy.2020.103007

Liu, S., Yu, C., Conner, B. T., Wang, S., Lai, W., and Zhang, W. (2017). Autistic traits and internet gaming addiction in Chinese children: The mediating effect of emotion regulation and school connectedness. Res. Dev. Disabil. 68, 122-130. doi:10.1016/j.ridd.2017.07.011

Mazurek, M. O., and Engelhardt, C. R. (2013a). Video game use in boys with autism spectrum disorder, ADHD, or typical development. Pediatrics, 132(2), 260-266. doi:10.1542/peds.2012-3956

Mazurek, M. O., and Engelhardt, C. R. (2013b). Video game use and problem behaviors in boys with autism spectrum disorders. Res. Autism Spectr. Disord. 7, 316-324. doi:10.1016/j.rasd.2012.09.008

Mazurek, M. O., Engelhardt, C. R., and Clark, K. E. (2015). Video games from the perspective of adults with autism spectrum disorder. Comput. Human Behav. 51, 122-130.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. J. Pers. Soc. Psychol. 52, 1258.

Mendenhall Z., Saad G., Nepomuceno M.V. (2010) “Homo Virtualensis: Evolutionary Psychology as a Tool for Studying Video Games,” In: Kock N. (eds) Evolutionary Psychology and Information Systems Research. Integrated Series in Information Systems, 24. (Springer, Boston, MA), doi:10.1007/978-1-4419-6139-6_14

Menear, K. S., and Ernest, J. M. (2020). Comparison of physical activity, TV/video watching/gaming, and usage of a portable electronic devices by children with and without autism spectrum disorder. Matern. Child Health J. 24, 1464-1472. doi: 10.1007/s10995-020-03013-2

Murray, A., Mannion, A., Chen, J. L., and Leader, G. (2021). Gaming Disorder in Adults with Autism Spectrum Disorder. J Autism Dev Disord, 1-8. doi:10.1007/s10803-021-05138-x

Nepomuceno, M. V., Saad, G., Stenstrom, E., and Mendenhall, Z. (2010). “Finger Length Ratio and Attitudes Toward Several Product Categories,” in NA - Advances in Consumer Research Volume 37, ed. M.C. Campell, J. Inman, and R. Pieters (MN: Association for Consumer Research), 872-872.

Nowell A. (2016) “Childhood, Play and the Evolution of Cultural Capacity in Neanderthals and Modern Humans,”. In: The Nature of Culture. Vertebrate Paleobiology and Paleoanthropology, ed. Haidle M., Conard N., Bolus M. (Springer, Dordrecht) doi:10.1007/978-94-017-7426-0_9

Olson, C. K., Kutner, L. A., Warner, D. E., Almerigi, J. B., Baer, L., Nicholi II, A. M., and Beresin, E. V. (2007). Factors correlated with violent video game use by adolescent boys and girls. J. Adolesc. Health. 41, 77-83. doi:10.1016/j.jadohealth.2007.01.001

Ostrov, J. M., and Keating, C. F. (2004). Gender differences in preschool aggression during free play and structured interactions: An observational study. Social development, 13, 255-277. doi:10.1111/j.1467-9507.2004.000266.x

Park, H. R., Lim, V. K., Kirk, I. J., and Waldie, K. E. (2015). P50 sensory gating deficits in schizotypy. Pers. Individ. Dif. 82, 142-147. doi:10.1016/j.paid.2015.03.025

Paulus, F. W., Sander, C. S., Nitze, M., Kramatschek-Pfahler, A. R., Voran, A., and von Gontard, A. (2019). Gaming disorder and computer-mediated communication in children and adolescents with autism spectrum disorder. Z. Kinder Jugendpsychiatr Psychother. doi:10.1024/1422-4917/a000674

Peever, N., Johnson, D., and Gardner, J. (2012). Personality and video game genre preferences. In Proceedings of the 8th australasian conference on interactive entertainment: Playing the system. 1-3. doi:10.1145/2336727.2336747

Potard, C., Henry, A., Boudoukha, A. H., Courtois, R., Laurent, A., and Lignier, B. (2019). Video game players' personality traits: An exploratory cluster approach to identifying gaming preferences. Psychol. Pop. Media. Cult. doi:10.1037/ppm0000245

Pryce, C. R. (1995). "Determinants of motherhood in human and nonhuman primates: A biosocial model." In Motherhood in human and nonhuman primates: Biosocial determinants, ed. C. R. Pryce, R. D. Martin, and D. Skuse (Basel: Karger), 1-15.

R Core Team. (2021). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. www.R-project.org. [Accessed July 15, 2021].

Rehbein, F., Staudt, A., Hanslmaier, M., and Kliem, S. (2016). Video game playing in the general adult population of Germany: Can higher gaming time of males be explained by gender specific genre preferences?. Comput. Human Behav, 55, 729-735. doi:10.1016/j.chb.2015.10.016

Roché, M. W., Fowler, M. L., and Lenzenweger, M. F. (2015). Deeper into schizotypy and motor performance: investigating the nature of motor control in a non-psychiatric sample. Psychiatry research, 228(1), 20-25. doi:10.1016/j.psychres.2015.03.016

Roché, M. W., Fowler, M. L., and Lenzenweger, M. F. (2015). Deeper into schizotypy and motor performance: investigating the nature of motor control in a non-psychiatric sample. Psychiatry Res. 228, 20-2. doi: 10.1016/j.psychres.2015.03.016

Schimmenti, A., Infanti, A., Badoud, D., Laloyaux, J., and Billieux, J. (2017). Schizotypal personality traits and problematic use of massively-multiplayer online role-playing games (MMORPGs). Comput. Hum. Behav. Rep. 74, 286-293. doi:10.1016/j.chb.2017.04.048

Scott, D. (1995). The effect of video games on feelings of aggression. J. Psychol. 129, 121-132. doi:10.1080/00223980.1995.9914952

Servin, A., Bohlin, G., and Berlin, L. (1999). Sex differences in 1-, 3-, and 5-year-olds' toy-choice in a structured play-session. Scand. J. Psychol. 40, 43-48. doi:10.1111/1467-9450.00096

Shanis, J. M., and Hedge, A. (2003). Comparison of mouse, touchpad and multitouch input technologies. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 47. 746-750. doi:10.1177/154193120304700418

Slater, M. D. (2003). Alienation, aggression, and sensation seeking as predictors of adolescent use of violent film, computer, and website content. J. Commun. 53, 105-121. doi:10.1111/j.1460-2466.2003.tb03008.x

Smith, P. K., and Boulton, M. (1990). Rough-and-tumble play, aggression and dominance: Perception and behaviour in children's encounters. Hum. Dev. 33, 271-282. doi:10.1159/000276524

Stoet, G. (2010). PsyToolkit - A software package for programming psychological experiments using Linux. Behav. Res. Methods. 42, 1096-1104. doi:10.3758/BRM.42.4.1096

Stoet, G. (2017). PsyToolkit: A novel web-based method for running online questionnaires and reaction-time experiments. Teach. Psychol. 44, 24-31. doi:10.1177/0098628316677643

Stotesbury, H., Gaigg, S. B., Kirhan, S., and Haenschel, C. (2018). The influence of schizotypal traits on attention under high perceptual load. Schizophr. Res. Cogn. 11, 6-10. doi:10.1016/j.scog.2017.10.002

Tabacchi, M. E., Caci, B., Cardaci, M., and Perticone, V. (2017). Early usage of Pokémon Go and its personality correlates. Comput. Human. Behav. 72, 163-169. doi:10.1016/j.chb.2017.02.047

Tondello, G. F., and Nacke, L. E. (2019). Player characteristics and video game preferences. Proc. Annu. Symp. Comput. Hum. Interact. Play. 365-378. doi:10.1145/3311350.3347185

Torner, H. P., Carbonell, X., and Castejón, M. (2019). A comparative analysis of the processing speed between video game players and non-players. Aloma: Revista de Psicologia, Ciències de l'Educació i de l'Esport, 37, 13-20. doi:10.51698/aloma.2019.37.1.13-20

Twenge, J. M. (2017). iGen: Why today's super-connected kids are growing up less rebellious, more tolerant, less happy – and completely unprepared for adulthood – and what that means for the rest of us. New York: Simon and Schuster.

Vygotsky, L. S. (1967). Play and its role in the mental development of the child. Soviet psychology, 5, 6-18. doi:10.2753/RPO1061-040505036

Wang, Z., Sapienza, A., Culotta, A., and Ferrara, E. (2019). Personality and behavior in role-based online games. In 2019 IEEE Conference on Games (CoG). IEEE. 1-8. doi: 10.1109/CIG.2019.8848027.

Watson, N. V., and Kimura, D. (1991). Nontrivial sex differences in throwing and intercepting: Relation to psychometrically-defined spatial functions. Pers. Individ. Dif. 12, 375-385. doi:10.1016/0191-8869(91)90053-E

Wendt, F. R., Muniz Carvalho, C., Pathak, G. A., Gelernter, J., and Polimanti, R. (2019). Deciphering the biological mechanisms underlying the genome-wide associations between computerized device use and psychiatric disorders. J. Clin. Med. 8, 2040. doi:10.3390/jcm8122040

Yang, W., Huang, T., Zeng, J., Chen, L., Mishra, S., and Liu, Y. E. (2020). Correlation Between Personality and Social Interactions in Online Strategy Games. In 2020 IEEE Conference on Games (CoG). IEEE. 756-759. doi:10.1109/CoG47356.2020.9231956

Yee, N. (2017) Genre-gender averages. Quantic Foundry. https://quanticfoundry.com/2017/01/19/female-gamers-by-genre/genre-gender-averages/#iLightbox[postimages]/0 [accessed Dec 18 2021].

2.7. Supplementary Materials

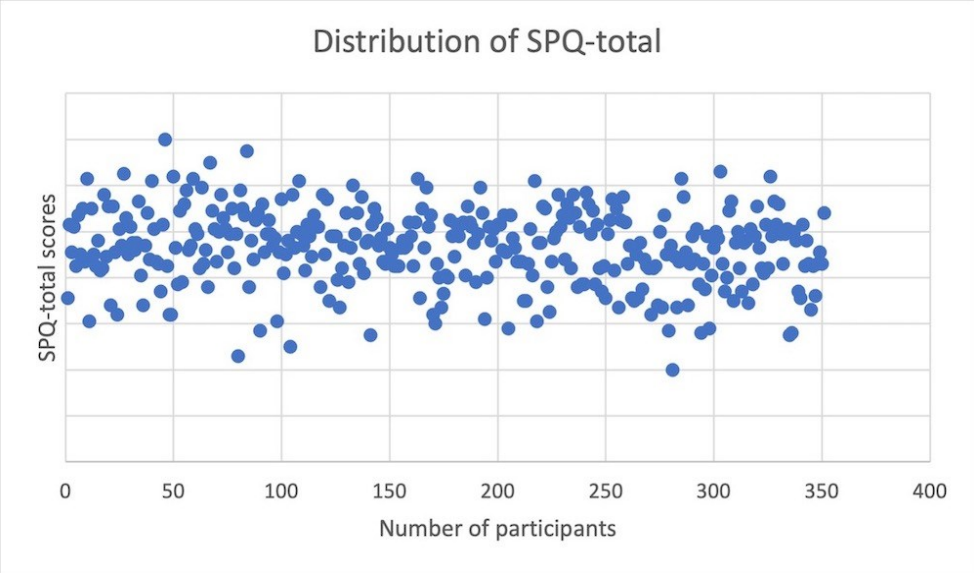

Figure 2.2 Distribution of SPQ-total scores in both genders pooled

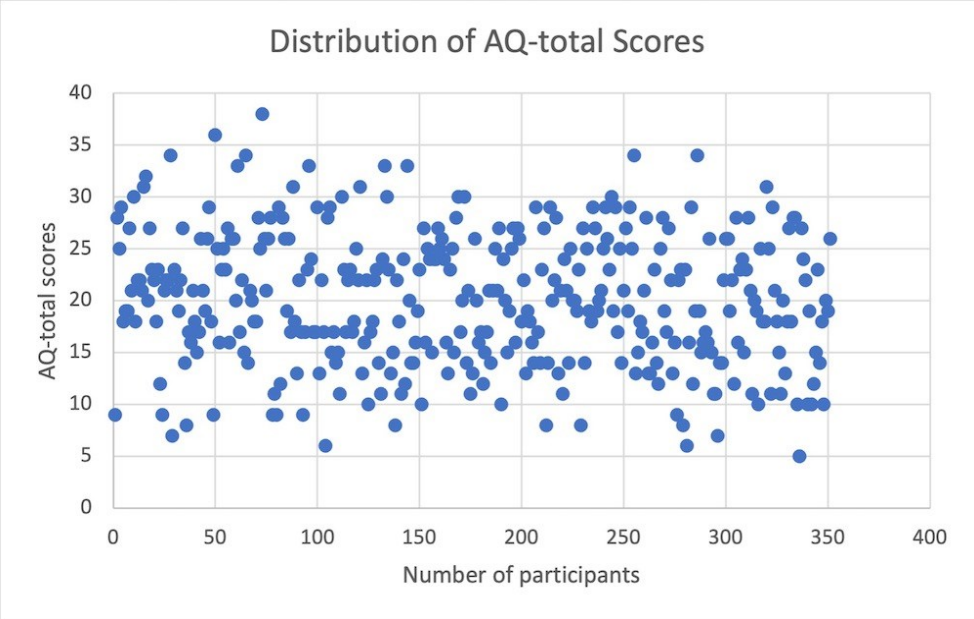

Figure 2.3 Distribution of AQ-total scores in both genders pooled

Table 2.3 Welch's t-tests on Gender Differences in AQ and SPQ, Video Game Usage, and Reaction Times and Targeting Times

Variables	Scores Mean ± SD (N)			t (df)	p value
AQ					
Social	F	3.50	± 2.49 (207)	1.91 (313)	0.06
	M	2.95	± 2.43 (144)		
AQ- Switch	F	5.73	± 1.91 (207)	1.05 (305)	0.30
	M	5.51	± 1.94 (144)		
AQ- Detail	F	5.34	± 2.07 (144)	1.08 (327)	0.28
	M	5.59	± 2.31 (207)		
AQ- Comm	F	3.22	± 2.19 (207)	0.12 (307)	0.91
	M	3.19	± 2.20 (144)		
AQ- Imag	F	2.50	± 1.54 (207)	0.05 (296)	0.96
	M	2.49	± 1.63 (144)		
AQ: Total	F	20.51	± 6.41 (207)	1.47 (309)	0.14
	M	19.49	± 6.38 (144)		
SPQ					
SPQ- Ideas	F	18.91	± 4.50 (207)	2.62 (294)	0.009
	M	17.58	± 4.81 (144)		
SPQ- Constrict	F	16.88	± 5.12 (207)	-1.30 (319)	0.20
	M	17.58	± 4.83 (144)		
SPQ- Eccentric	F	10.96	± 3.93 (207)	-0.94 (326)	0.35
	M	11.34	± 3.56 (144)		
SPQ- Anxiety	F	13.87	± 3.96 (207)	3.61 (302)	3.57E-04
	M	12.29	± 4.08 (144)		
SPQ- Magic	F	9.45	± 3.73 (207)	4.88 (315)	1.69E-06
	M	7.52	± 3.58 (144)		
SPQ- Speech	F	14.09	± 3.10 (207)	2.33 (300)	0.02
	M	13.29	± 3.23 (144)		
SPQ- Percep	F	10.81	± 3.07 (207)	1.62 (303)	0.11
	M	10.26	± 3.14 (144)		
SPQ- Interpersonal	F	30.74	± 7.54 (207)	1.09 (312)	0.28
	M	29.86	± 7.40 (144)		
Disorganized	F	94.97	± 16.20 (207)	2.87 (306)	0.004
	M	89.85	± 16.58 (144)		
Cog-SPQ- Percep	F	39.17	± 8.36 (207)	4.04 (296)	6.72E-05
	M	35.37	± 8.89 (144)		

SPQ: Total	F	94.97	± 16.20 (207)	2.87 (303)	0.004
	M	89.85	± 16.58 (144)		
Video Game Usage					
Weekday Time (h)	F	0.83	± 1.29 (207)	-7.96 (252)	5.89E-14
	M	2.17	± 1.71 (144)		
Weekend Time (h)	F	1.56	± 1.90 (207)	-9.10 (260)	2.40E-17
	M	3.75	± 2.41 (144)		
Self Report Frequency	F	3.66	± 2.16 (207)	11.79 (349)	2.03E-27
	M	5.93	± 1.45 (144)		
Self Report Usage	F	3.44	± 1.44 (207)	6.85 (329)	3.645E-11
	M	2.44	± 1.28 (144)		
Self Report Spare Time	F	1.84	± 1.02 (207)	-8.90 (282)	7.13E-17
	M	2.90	± 1.16 (144)		
Neurophysiological Indices					
Reaction time (ms)	F	286.28	± 33.95 (204)	-3.95 (302)	9.84E-05
	M	271.44	± 34.93 (144)		
Target Time (ms)	F	-163.20	± 100.22 (195)	-5.89 (280)	1.08E-08
	M	-93.53	± 111.07 (140)		

Table 2.4 Chi-Square Tests for Gender Differences in Video Game Genre Preferences and Motivations

Genre			N	χ^2	P
Puzzle	F	Yes	107	16.54	0.00005
		No	100		
	M	Yes	43		
		No	101		
Action	F	Yes	61	77.04	< 0.00001
		No	146		
	M	Yes	111		
		No	33		
Platformer	F	Yes	65	0.76	0.39
		No	142		
	M	Yes	39		
		No	105		
RPG	F	Yes	44	34.55	< 0.00001
		No	163		
	M	Yes	74		

		No	70		
Strategy	F	Yes	28	48.53	< 0.00001
		No	179		
	M	Yes	68		
		No	76		
Sports	F	Yes	29	14.11	0.0002
		No	178		
	F	Yes	44		
		No	100		
Racing	F	Yes	44	0.05	0.83
		No	163		
	M	Yes	32		
		No	112		
Construction	F	Yes	65	2.51	0.11
		No	142		
	M	Yes	57		
		No	87		
Social Simulation	F	Yes	76	22.27	< 0.00001
		No	131		
	M	Yes	20		
		No	124		
Idle	F	Yes	20	0.05	0.82
		No	187		
	M	Yes	15		
		No	129		
Motivations			**N**	**χ2**	**P**
Social interaction	F	Yes	61	19.39	0.00001
		No	146		
	M	Yes	76		
		No	68		
Stress relief	F	Yes	131	3.07	0.08
		No	76		
	M	Yes	104		
		No	40		
Skill Development	F	Yes	33	16.59	0.00005
		No	174		
	M	Yes	50		
		No	94		
	F	Yes	46	13.28	0.0003

Adrenaline Rush		No	161		
	M	Yes	58		
		No	86		
Escape	F	Yes	116	1.80	0.18
		No	91		
	M	Yes	91		
		No	53		
Fantasy	F	Yes	49	7.83	0.005
		No	158		
	M	Yes	54		
		No	90		
Customization	F	Yes	58	4.03	0.04
		No	149		
	M	Yes	55		
		No	89		

Table 2.5 ANCOVAs of Total AQ, Total SPQ, and SPQ Cog-Per scores in relation to Video Game Usage, with Gender as Interaction Term

Weekday time (h)						
	t trait	p trait	t sex	p sex	t interact	p interact
AQ- total	1.65	0.101	3.80	0.00017	-1.28	0.201
SPQ- Cog-Per	-0.63	0.530	1.94	0.053	-0.10	0.923
SPQ- total	-0.30	0.767	0.92	0.361	0.56	0.578
Weekend time (h)						
	t trait	p trait	t sex	p sex	t interact	p interact
AQ- total	2.73	0.007	4.21	0.00003	-1.29	0.197
SPQ- Cog-Per	-0.81	0.420	1.95	0.052	0.16	0.874
SPQ- total	0.69	0.488	1.56	0.119	0.13	0.900
Self Report Frequency						
	t trait	p trait	t sex	p sex	t interact	p interact
AQ- total	2.81	0.005	5.34	0.0000002	-2.01	0.045
SPQ- Cog-Per	-1.93	0.054	1.80	0.072	0.62	0.536
SPQ- total	-0.15	0.883	1.95	0.052	-0.04	0.971
Self Report Usage	t trait	p trait	t sex	p sex	t interact	p interact
AQ- total	-3.07	0.002	-4.57	6.72E-06	2.58	0.010
SPQ- Cog-Per	-0.59	0.553	-2.06	0.040	0.54	0.590
SPQ- total	-1.57	0.117	-1.45	0.147	0.23	0.819
Self report spare time	t trait	p trait	t sex	p sex	t interact	p interact
AQ- total	1.45	0.147	3.19	0.002	-0.40	0.693
SPQ- Cog-Per	-2.30	0.022	0.82	0.414	1.19	0.236
SPQ- total	-0.45	0.655	0.31	0.754	1.32	0.189

Table 2.6 Pearson Correlations of AQ and SPQ subscale scores with Measures of Video Game Usage

Video Game Usage	Weekday time (h)	Weekend time (h)	Self report frequency	Self report usage	Self report spare time
Females (N = 207)					
AQ: Social	0.11	0.18**	0.18**	-0.17*	0.12
AQ: Switch	-0.04	0.04	0.06	-0.06	0.02
AQ: Detail	0.16*	0.12	0.06	-0.04	0.06
AQ: Comm	0.04	0.12	0.07	-0.12	0.06
AQ: Imag	0.11	0.17*	0.15*	-0.10	0.07
SPQ: Ideas	-0.03	-0.01	-0.09	-0.04	-0.11
SPQ: Constrict	-0.12	-0.02	0.00	-0.07	-0.04
SPQ: Eccentric	0.05	0.13	0.06	-0.12	0.13
SPQ: Anxiety	0.08	0.17*	0.12	-0.11	0.11
SPQ: Magic	-0.03	-0.11	-0.11	-0.02	-0.15*
SPQ: Speech	0.04	0.10	0.04	-0.03	0.04
SPQ: Percep	-0.06	-0.03	-0.05	-0.03	-0.13
SPQ: Interpersonal	-0.04	0.08	0.07	-0.11	0.03
SPQ: Disorganized	0.07	0.14*	0.06	-0.10	0.11
Males (N = 144)					
AQ: Social	-0.09	0.06	-0.001	0.08	0.07
AQ: Switch	-0.01	-0.01	-0.02	0.12	-0.05
AQ: Detail	0.06	0.02	-0.01	-0.06	0.05
AQ: Comm	0.05	0.14	0.04	-0.09	0.18*
AQ: Imag	-0.08	-0.14	-0.06	0.15	-0.13
SPQ: Ideas	0.06	0.06	-0.05	-0.06	0.06
SPQ: Constrict	-0.03	0.00	0.03	-0.09	0.08
SPQ: Eccentric	0.10	0.13	0.14	-0.20*	0.18*
SPQ: Anxiety	0.08	0.07	0.03	-0.02	0.12
SPQ: Magic	-0.11	-0.08	-0.14	0.17*	-0.17*
SPQ: Speech	0.14	0.15	-0.05	-0.15	0.15
SPQ: Percep	-0.11	-0.10	-0.03	-0.05	-0.001
SPQ: Interpersonal	0.03	0.04	0.01	-0.07	0.12
SPQ: Disorganized	0.14	0.16	0.08	-0.20*	0.19*
Both Genders (N=351)					
AQ: Social	-0.03	0.07	0.05	-0.03	0.04
AQ: Switch	0.05	-0.01	-0.02	0.03	-0.04

AQ: Comm	0.04	0.11	0.04	-0.09	0.09
AQ: Attention to Detail	0.03	0.02	0.07	0.003	-0.01
SPQ: Ideas	-0.05	-0.04	-0.13**	0.01	-0.08
SPQ: Constrict	-0.04	0.02	0.03	-0.10	0.05
SPQ: Eccentric	0.08	0.14*	0.09	-0.15**	0.16**
SPQ: Anxiety	-0.01	0.02	-0.03	-0.001	0.02
SPQ: Magic	-0.16**	-0.20***	-0.23***	0.13**	-0.25***
SPQ: Speech	0.03	0.05	-0.05	-0.03	0.02
SPQ: Percep	-0.11*	-0.09	-0.81	-0.01	-0.10
SPQ: Interpersonal	-0.03	0.03	0.01	-0.06	0.04
SPQ: Disorganized	0.05	0.12*	0.03	-0.11*	0.11*

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Table 2.7 ANCOVAs of AQ and SPQ subscales in relation to Video Game Usage

Weekday time (h)				
	t trait	**p trait**	**t sex**	**p sex**
AQ- Social	0.26	0.80	8.33	1.82663E-15
AQ- Switch	-0.47	0.64	8.31	2.12419E-15
AQ- Detail	2.14	0.03	8.51	5.16871E-16
AQ- Comm	0.88	0.38	8.36	1.47431E-15
AQ- Imag	0.30	0.76	8.35	1.61269E-15
SPQ- Ideas	0.25	0.80	8.30	2.27628E-15
SPQ- Constrict	-1.38	0.17	8.45	8.18346E-16
SPQ- Eccentric	1.33	0.19	8.30	2.4011E-15
SPQ- Anxiety	1.50	0.13	8.51	5.24111E-16
SPQ- Magic	-1.22	0.22	7.79	7.57637E-14
SPQ- Speech	1.65	0.10	8.52	4.79066E-16
SPQ- Percep	-1.50	0.13	8.22	4.21926E-15
	-0.12	0.91	8.33	1.89144E-15
Weekend time (h)				
	t trait	**p trait**	**t sex**	**p sex**
AQ- Social	2.36	0.02	9.74	5.47377E-20
AQ- Switch	0.33	0.74	9.48	4.05245E-19
AQ- Detail	1.47	0.14	9.57	2.00166E-19
AQ- Comm	2.48	0.01	9.57	1.98204E-19

AQ- Imag	0.39	0.70	9.48	4.11111E-19
SPQ- Ideas	0.48	0.63	9.45	5.00629E-19
SPQ- Constrict	-0.15	0.88	9.46	4.60038E-19
SPQ- Eccentric	2.42	0.02	9.42	6.23987E-19
SPQ- Anxiety	2.32	0.02	9.82	3.0562E-20
SPQ- Magic	-1.85	0.07	8.75	9.09994E-17
SPQ- Speech	2.29	0.02	9.76	4.82997E-20
SPQ- Percep	-1.14	0.25	9.36	1.02677E-18
	1.14	0.26	9.54	2.51555E-19

Self report frequency

	t trait	p trait	t sex	p sex
AQ- social	2.29	0.02	11.26	2.75995E-25
AQ- Switch	0.28	0.78	11.00	2.31854E-24
AQ- Detail	0.64	0.52	11.03	1.87766E-24
AQ- Comm	1.19	0.23	11.03	1.80987E-24
AQ- Imag	1.53	0.13	11.04	1.64169E-24
SPQ- Ideas	-1.39	0.17	10.73	2.166E-23
SPQ- Constrict	-0.07	0.95	10.98	2.75402E-24
SPQ- Eccentric	1.56	0.12	10.95	3.54442E-24
SPQ- Anxiety	1.68	0.09	11.17	6.01766E-25
SPQ- Magic	-2.27	0.02	10.16	2.08945E-21
SPQ- Speech	0.43	0.67	10.97	2.94436E-24
SPQ- Percep	-0.86	0.39	10.90	5.46009E-24
	0.86	0.39	11.04	1.62679E-24

Self report usage

	t trait	p trait	t sex	p sex
AQ- Social	-1.38	0.17	-6.82	4.00094E-11
AQ- Switch	0.19	0.85	-6.68	9.64936E-11
AQ- Detail	-1.91	0.06	-6.83	3.77794E-11
AQ- Comm	-2.02	0.04	-6.75	6.20419E-11
AQ- Imag	0.01	1.00	-6.70	8.4876E-11
SPQ- Ideas	-0.85	0.39	-6.76	5.87755E-11
SPQ- Constrict	-1.47	0.14	-6.60	1.51157E-10
SPQ- Eccentric	-2.75	0.01	-6.63	1.30693E-10
SPQ- Anxiety	-1.39	0.17	-6.86	3.18905E-11
SPQ- Magic	0.93	0.35	-6.26	1.13849E-09
SPQ- Speech	-1.48	0.14	-6.85	3.34411E-11
SPQ- Percep	-0.70	0.49	-6.74	6.65514E-11
	-1.73	0.09	-6.82	4.14394E-11

Self report spare time				
	t trait	p trait	t sex	p sex
AQ- Social	1.75	0.08	9.26	2.12E-18
AQ- Switch	-0.23	0.82	9.07	9.23E-18
AQ- Detail	1.01	0.31	9.15	5.01E-18
AQ- Comm	2.03	0.04	9.16	4.63E-18
AQ- Imag	-0.35	0.73	9.09	7.54E-18
SPQ- Ideas	-0.50	0.62	8.93	2.42E-17
SPQ- Constrict	0.29	0.77	9.05	1.02E-17
SPQ- Eccentric	2.89	0.004	9.05	1.06E-17
SPQ- Anxiety	2.13	0.03	9.39	8.16E-19
SPQ- Magic	-2.98	0.003	8.16	6.03E-15
SPQ- Speech	1.69	0.09	9.27	2.03E-18
SPQ- Percep	-1.34	0.18	8.96	1.95E-17
	1.33	0.18	9.18	4.02E-18

Table 2.8 Video Game Genre Preferences in relation to AQ-Total, SPQ-Total, and SPQ-CogPer scores

Variables		Scores Mean ± SD (N)			T (df)	p value
Action						
AQ- Total	F	Y	21.50	± 5.88 (61)	1.47(205)	0.14
		N	20.10	± 6.59 (146)		
	M	Y	19.10	± 6.28 (111)	-1.27 (142)	0.21
		N	20.70	± 6.65 (33)		
	B	Y	20.00	± 6.23 (172)	-0.34 (349)	0.74
		N	20.20	± 6.59 (179)		
SPQ- Total	F	Y	97.50	± 13.50 (61)	1.44 (205)	0.15
		N	93.90	± 17.10 (146)		
	M	Y	90.60	± 16.40 (111)	0.97 (142)	0.33
		N	87.40	± 17.30 (33)		
	B	Y	93.00	± 15.70 (172)	0.18 (349)	0.86
		N	92.70	± 17.30(179)		
SPQ-CogPer	F	Y	39.60	± 8.68 (61)	0.50 (205)	0.62
		N	39.00	± 8.24 (146)		
	M	Y	35.60	± 9.01 (111)	0.60 (142)	0.55
		N	34.50	± 8.55 (33)		

	B	Y	37.00	± 9.07 (172)	-1.21 (349)	0.23
		N	38.20	± 8.46 (179)		
Platformer						
AQ- Total	F	Y	20.20	± 6.13 (65)	-0.52 (205)	0.60
		N	20.70	± 6.55 (142)		
	M	Y	17.50	± 7.28 (39)	-2.34 (142)	0.02
		N	20.20	± 5.87 (105)		
	B	Y	19.20	± 6.67 (104)	-1.77 (349)	0.08
		N	20.50	± 6.26 (247)		
SPQ-Total	F	Y	96.00	± 17.70 (65)	0.61 (205)	0.54
		N	94.50	± 15.50 (142)		
	M	Y	89.30	± 19.10 (39)	-0.26 (142)	0.79
		N	90.10	± 15.60 (105)		
	B	Y	93.50	± 18.40 (104)	0.44 (349)	0.66
		N	92.60	± 15.70 (247)		
SPQ-CogPer	F	Y	39.70	± 9.37 (65)	0.57 (205)	0.57
		N	39.00	± 7.88 (142)		
	M	Y	34.50	± 9.64 (39)	-0.68 (142)	0.50
		N	35.70	± 8.62 (105)		
	B	Y	37.70	± 9.75 (104)	0.18 (349)	0.86
		N	37.60	± 8.34 (247)		
Puzzle						
AQ- Total	F	Y	20.70	± 6.55 (205)	0.42 (205)	0.68
		N	20.30	± 6.29 (205)		
	M	Y	19.10	± 7.16 (43)	-0.52 (142)	0.60
		N	19.70	± 6.04 (101)		
	B	Y	20.20	± 6.74 (150)	0.34 (349)	0.74
		N	20.00	± 6.16 (201)		
SPQ- Total	F	Y	97.50	± 14.90 (107)	2.33 (205)	0.02
		N	92.30	± 17.10 (100)		
	M	Y	93.00	± 15.70 (43)	1.51 (142)	0.13
		N	88.50	± 16.80 (101)		
	B	Y	96.20	± 15.20 (150)	3.31 (349)	0.001
		N	90.40	± 17.10 (201)		
SPQ-CogPer	F	Y	40.40	± 7.93 (107)	2.16 (205)	0.03
		N	37.90	± 8.65 (100)		
	M	Y	36.30	± 9.37 (43)	0.78 (142)	0.44
		N	35.00	± 8.69 (101)		
	B	Y	39.20	± 8.54 (150)	2.95 (349)	0.003

		N	36.40	± 8.77 (201)		
RPG						
AQ- Total	F	Y	23.00	± 7.33 (44)	2.93 (205)	0.0038
		N	19.80	± 5.99(163)		
	M	Y	19.40	± 6.74 (74)	-0.27 (142)	0.78
		N	19.60	± 6.01 (70)		
	B	Y	20.70	± 7.15 (118)	1.27 (349)	0.21
		N	19.80	± 5.98 (233)		
SPQ-Total	F	Y	95.80	± 18.20 (44)	0.40 (205)	0.69
		N	94.70	± 15.70 (163)		
	M	Y	90.60	± 15.80 (74)	0.53 (142)	0.60
		N	89.10	± 17.40 (70)		
	B	Y	92.50	± 16.90 (118)	-0.27 (349)	0.79
		N	93.00	± 16.40 (233)		
SPQ-CogPer	F	Y	37.70	± 9.54 (44)	-1.34 (205)	0.18
		N	39.60	± 8.00 (163)		
	M	Y	35.20	± 8.94 (74)	-0.28 (142)	0.78
		N	35.60	± 8.89 (70)		
	B	Y	36.10	± 9.21 (118)	-2.31 (349)	0.02
		N	38.40	± 8.46 (233)		
Strategy						
AQ-Total	F	Y	21.30	± 5.15(28)	0.72 (205)	0.47
		N	20.40	± 6.59 (179)		
	M	Y	19.60	± 6.99 (68)	0.14 (142)	0.89
		N	19.40	± 5.82 (76)		
	B	Y	20.10	± 6.53 (96)	-0.02 (349)	0.98
		N	20.10	± 6.37 (255)		
SPQ-Total	F	Y	93.60	± 11.60 (28)	-0.46 (205)	0.64
		N	95.20	± 16.80 (179)		
	M	Y	92.50	± 17.20 (68)	1.86 (142)	0.07
		N	87.50	± 15.70 (76)		
	B	Y	92.90	± 15.70 (96)	-0.01 (349)	0.99
		N	92.90	± 16.90 (255)		
SPQ-CogPer	F	Y	37.50	± 7.08 (28)	-1.12 (205)	0.27
		N	39.40	± 8.53 (179)		
	M	Y	36.40	± 9.15 (68)	1.32 (142)	0.19
		N	34.40	± 8.60 (76)		
	B	Y	36.70	± 8.58 (96)	-1.16 (349)	0.25
		N	37.90	± 8.83 (255)		

Sports						
AQ-Total	F	Y	18.60	± 4.95 (29)	-1.75 (205)	0.08
		N	20.80	± 6.57 (178)		
	M	Y	17.90	± 5.79 (44)	-2.06 (142)	0.04
		N	20.20	± 6.51 (100)		
	B	Y	18.20	± 5.45 (73)	-2.94 (349)	0.004
		N	20.60	± 6.55 (278)		
SPQ-Total	F	Y	91.10	± 14.30 (29)	-1.40 (205)	0.16
		N	95.60	± 16.40 (178)		
	M	Y	89.90	± 20.20 (44)	0.03 (142)	0.98
		N	89.80	± 14.80 (100)		
	B	Y	90.40	± 18.00 (73)	-1.45 (349)	0.15
		N	93.50	± 16.10 (278)		
SPQ-CogPer	F	Y	37.90	± 8.13 (29)	-0.89 (205)	0.38
		N	39.40	± 8.40 (178)		
	M	Y	36.60	± 10.90 (44)	1.14 (142)	0.26
		N	34.80	± 7.81 (100)		
	B	Y	37.10	± 9.88 (73)	-0.52 (349)	0.60
		N	37.70	± 8.47 (278)		
Racing						
AQ- Total	F	Y	20.60	± 5.47 (44)	0.12 (205)	0.91
		N	20.50	± 6.65 (163)		
	M	Y	20.40	± 6.18 (32)	0.95 (142)	0.34
		N	19.20	± 6.43 (112)		
	B	Y	20.60	± 5.74 (76)	0.68 (349)	0.49
		N	20.00	± 6.58 (275)		
SPQ-Total	F	Y	97.10	± 14.90 (44)	0.97 (205)	0.33
		N	94.40	± 16.50 (163)		
	M	Y	94.80	± 13.20 (32)	1.95 (142)	0.053
		N	88.40	± 17.20 (112)		
	B	Y	96.10	± 14.20 (76)	1.95 (349)	0.05
		N	92.00	± 17.00 (275)		
SPQ-CogPer	F	Y	40.30	± 8.29 (44)	1.00 (205)	0.32
		N	38.90	± 8.38 (163)		
	M	Y	39.10	± 8.42 (32)	2.73 (142)	0.007
		N	34.30	± 8.77 (112)		
	B	Y	39.80	± 8.31 (76)	2.45 (349)	0.015
		N	37.00	± 8.81 (275)		

Construction						
AQ- Total	F	Y	22.40	± 6.48 (65)	2.85 (205)	0.0049
		N	19.70	± 6.22 (142)		
	M	Y	19.70	± 6.93 (57)	0.32 (142)	0.75
		N	19.40	± 6.02 (87)		
	B	Y	21.10	± 6.80 (122)	2.19 (349)	0.03
		N	19.60	± 6.13 (229)		
SPQ-Total	F	Y	95.80	± 16.50 (65)	0.48 (205)	0.63
		N	94.60	± 16.10 (142)		
	M	Y	89.20	± 17.40 (57)	-0.39 (142)	0.70
		N	90.30	± 16.10 (87)		
	B	Y	92.70	± 17.20 (122)	-0.14 (349)	0.89
		N	92.00	± 16.20 (229)		
SQ-Cog-Per	F	Y	38.20	± 8.23 (65)	-1.19 (205)	0.24
		N	39.60	± 8.41 (142)		
	M	Y	34.00	± 9.00 (57)	-1.46 (142)	0.15
		N	36.20	± 8.75 (87)		
	B	Y	36.20	± 8.81 (122)	-2.17 (349)	0.03
		N	38.30	± 8.68 (229)		
Social Simulation						
AQ- Total	F	Y	22.20	± 6.48 (76)	1.13 (205)	0.26
		N	20.10	± 6.36 (131)		
	M	Y	20.10	± 7.40 (20)	0.42 (142)	0.68
		N	19.40	± 6.22 (124)		
	B	Y	20.90	± 6.66 (96)	1.52 (349)	0.13
		N	19.80	± 6.29 (255)		
SPQ-Total	F	Y	96.80	± 17.70 (76)	1.23 (205)	0.22
		N	93.90	± 15.20 (131)		
	M	Y	91.00	± 19.00 (20)	0.35 (142)	0.73
		N	89.70	± 16.20 (124)		
	B	Y	95.60	± 18.00 (96)	1.90 (349)	0.058
		N	91.80	± 15.80 (255)		
SPQ-CogPer	F	Y	39.40	± 9.08 (76)	0.29 (205)	0.77
		N	39.00	± 7.94 (131)		
	M	Y	35.80	± 10.10 (20)	0.23 (142)	0.82
		N	35.30	± 8.72 (124)		
	B	Y	38.60	± 9.36 (96)	1.36 (349)	0.18
		N	37.20	± 8.52 (255)		

Idle						
AQ- Total	F	Y	21.90	± 5.22 (20)	1.02 (205)	0.31
		N	20.40	± 6.52 (187)		
	M	Y	21.90	± 5.83 (15)	1.53 (142)	0.13
		N	19.20	± 6.40 (129)		
	B	Y	21.90	± 5.41 (35)	1.75 (349)	0.08
		N	19.90	± 6.48 (316)		
SPQ-Total	F	Y	94.50	± 15.80 (20)	-0.15 (205)	0.88
		N	95.00	± 16.30 (187)		
	M	Y	91.60	± 17.60 (15)	0.43(142)	0.67
		N	89.70	± 16.50 (129)		
	B	Y	93.20	± 16.40 (35)	0.14 (349)	0.89
		N	92.80	± 16.60 (316)		
SPQ-CogPer	F	Y	38.90	± 7.90 (20)	-0.18 (205)	0.86
		N	39.20	± 8.43 187()		
	M	Y	34.00	± 9.77 (15)	-0.63 (142)	0.53
		N	35.50	± 8.80 (129)		
	B	Y	36.80	± 8.95 (35)	-0.60 (349)	0.55
		N	37.70	± 8.76 (316)		

Females = 207, Males = 144, Both = 351. F = females, M = males, B=both genders.

Table 2.9 Stepwise Regression Analyses of AQ and SPQ scores in relation to Video Game Genre Preferences

Puzzle					
#	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	**Significance**
#(Intercept)	-1.51323	0.48524	-3.118	0.001818	**
#AQ-Imag	-0.17066	0.07576	-2.253	0.024287	*
#SPQ- Eccentric	0.13749	0.03181	4.322	1.54E-05	***
#SPQ-Magic	0.05395	0.03135	1.721	0.085245	
#sexM	-0.9549	0.24713	-3.864	0.000112	***
Action					
#(Intercept)	-1.89453	0.41886	-4.523	6.09E-06	***
#AQ-Social	-0.08123	0.05261	-1.544	0.12259	
#SPQ- Eccentric	0.11546	0.03516	3.284	0.00102	**
#sexM	2.08247	0.25588	8.139	4.00E-16	***
Platformer					
#(Intercept)	-1.33622	0.37984	-3.518	0.000435	***
#AQ-Social	-0.09942	0.05103	-1.948	0.051408	
#SPQ- Eccentric	0.0698	0.03264	2.138	0.032507	*
RPG					
#(Intercept)	-1.76468	0.56657	-3.115	0.00184	**
#AQ-Social	0.10701	0.05107	2.095	0.03614	*
#SPQ- Ideas	-0.06357	0.02866	-2.218	0.02656	*
#SPQ- Eccentric	0.1097	0.03725	2.945	0.00323	**
#sexM	1.38089	0.25022	5.519	3.41E-08	***
Strategy					
#(Intercept)	-2.33546	0.5477	-4.264	2.01E-05	***
#AQ- Switch	-0.12767	0.07105	-1.797	0.07235	
#SPQ- Eccentric	0.10477	0.03723	2.814	0.00489	**
#sexM	1.73843	0.26751	6.499	8.11E-11	***
Sports					
#(Intercept)	-1.80606	0.66455	-2.718	0.006574	**
#AQ- Switch	-0.13697	0.079	-1.734	0.082961	

#AQ- Comm	-0.22088	0.07947	-2.779	0.005447	**
#SPQ- Constrict	0.04847	0.03117	1.555	0.119915	
#SPQ- Magic	0.05772	0.03728	1.548	0.121599	
#sexM	1.09101	0.28916	3.773	0.000161	***
Racing					
#(Intercept)	-2.38204	0.46174	-5.159	2.49E-07	***
#AQ- Detail	0.09746	0.06138	1.588	0.1124	
#SPQ- Magic	0.0611	0.03403	1.796	0.0726	
Construction					
#(Intercept)	-0.72016	0.62183	-1.158	0.2468	
#AQ-Social	0.11016	0.04741	2.324	0.0201	*
#SPQ- Ideas	-0.05226	0.02753	-1.898	0.0577	
#SPQ- Magic	-0.06593	0.0334	-1.974	0.0484	*
#SPQ- Speech	0.08917	0.03895	2.289	0.0221	*
Social Simulation					
#(Intercept)	-1.28107	0.5828	-2.198	0.0279	*
#AQ- Switch	0.10863	0.06891	1.576	0.115	
#AQ- Detail	-0.09946	0.05649	-1.761	0.0783	
#SPQ- Eccentric	0.05913	0.03457	1.71	0.0872	
#sexM	-1.33153	0.2858	-4.659	3.18E-06	***
Idle					
#(Intercept)	-3.50343	0.66148	-5.296	1.18E-07	***
#social	0.1517	0.09335	1.625	0.1041	
#AQ- Switch	0.21382	0.11318	1.889	0.0589	
#AQ- Comm	-0.15725	0.11249	-1.398	0.1622	

Game Type Choice by AQ-Total, SPQ-Total, SPQ-CogPer and gender

Puzzle #	Estimate	Std. Error	z-value	Pr(>|z|)
#(Intercept)	-0.118893	0.467646	-0.254	0.799
#AQ-total	0.009098	0.02178	0.418	0.676
#sexM	-0.4451	0.746599	-0.596	0.551
#AQ- total:sexM	-0.024064	0.036038	-0.668	0.504

Action					
#(Intercept)	-1.60712	0.53062	-3.029	0.00246	**
#AQ- total	0.0353	0.02409	1.466	0.14276	
#sexM	3.62131	0.86051	4.208	2.57E-05	***
#AQ- total:sexM	-0.0755	0.03989	-1.893	0.0584	
Platformer					
#(Intercept)	-0.53114	0.50056	-1.061	0.289	
#AQ-Total	-0.01226	0.0235	-0.522	0.602	
#sexM	0.86546	0.77838	1.112	0.266	
#AQ- total:sexM	-0.05799	0.03885	-1.493	0.136	
RPG					
#(Intercept)	-2.99672	0.64555	-4.642	3.45E-06	***
#AQ- Total	0.07881	0.02794	2.82	0.004801	**
#sexM	3.19316	0.84072	3.798	0.000146	***
#AQ- total:sexM	-0.08603	0.03835	-2.243	0.024866	*
Strategy					
#(Intercept)	-2.3316	0.70327	-3.315	0.000915	***
#AQ- Total	0.02285	0.03177	0.719	0.472003	
#sexM	2.1467	0.88606	2.423	0.015404	*
#AQ- total:sexM	-0.01907	0.04123	-0.463	0.643708	
Sports					
#(Intercept)	-0.702094	0.647946	-1.084	0.2786	
#AQ- Total	-0.05648	0.032573	-1.734	0.0829	
#sexM	1.01263	0.868298	1.166	0.2435	
#AQ- total:sexM	-0.002963	0.043931	-0.067	0.9462	
Racing					
#	**Estimate**	**Std. Error**	**z-value**	**Pr(>|z|)**	
#(Intercept)	-1.374363	0.572545	-2.4	0.0164	*
#AQ- Total	0.003154	0.026559	0.119	0.9055	
#sexM	-0.479859	0.884456	-0.543	0.5874	
#AQ- total:sexM	0.027174	0.041512	0.655	0.5127	

Construction					
#(Intercept)	-2.19981	0.54799	-4.014	5.96E-05	***
#AQ-Total	0.06752	0.02451	2.755	0.00588	**
#sexM	1.60969	0.77802	2.069	0.03855	*
#AQ- total:sexM	-0.05896	0.03636	-1.622	0.10488	
Social Simulation					
#(Intercept)	-1.072182	0.493229	-2.174	0.0297	*
#AQ- total	0.025556	0.022688	1.126	0.26	
#sexM	-1.069396	0.937451	-1.141	0.254	
#AQ- total:sexM	-0.009486	0.044317	-0.214	0.8305	
Idle					
#(Intercept)	-3.02785	0.8354	-3.624	0.00029	***
#AQ- total	0.0375	0.03686	1.018	0.30886	
#sexM	-0.51805	1.30974	-0.396	0.69245	
#AQ- total:sexM	0.03031	0.05814	0.521	0.60206	
Puzzle					
#(Intercept)	-1.35935	0.68802	-1.976	0.0482	*
#SPQ- Cog-Per	0.03645	0.01721	2.118	0.0341	*
#sexM	-0.07061	1.02704	-0.069	0.9452	
#SPQ- Cog-Per:sexM	-0.02028	0.02687	-0.755	0.4504	
Action					
#(Intercept)	-1.234576	0.741326	-1.665	0.0958	
#SPQ- Cog-Per	0.009206	0.018395	0.5	0.6168	
#sexM	1.967776	1.096967	1.794	0.0728	
#SPQ- Cog-Per:sexM	0.004473	0.029086	0.154	0.8778	
Platformer					
#(Intercept)	-1.18562	0.72866	-1.627	0.104	
#SPQ- Cog-Per	0.01028	0.01808	0.569	0.57	
#sexM	0.70731	1.05739	0.669	0.504	
#SPQ- Cog-Per:sexM	-0.02487	0.02795	-0.89	0.374	

RPG					
#(Intercept)	-0.26627	0.79159	-0.336	0.737	
#SPQ- Cog-Per	-0.027	0.02028	-1.331	0.183	
#sexM	0.51302	1.04825	0.489	0.625	
#SPQ- Cog-Per:sexM	0.0216	0.02768	0.78	0.435	
Strategy					
#(Intercept)	-0.82325	0.93266	-0.883	0.3774	
#SPQ- Cog-Per	-0.02681	0.02407	-1.114	0.2653	
#sexM	-0.17698	1.16529	-0.152	0.8793	
#SPQ- Cog-Per:sexM	0.05191	0.03074	1.689	0.0913	
Sports					
#(Intercept)	-1.00003	0.92707	-1.079	0.281	
#SPQ- Cog-Per	-0.02108	0.02375	-0.888	0.375	
#sexM	-0.65724	1.20225	-0.547	0.585	
#SPQ- Cog-Per:sexM	0.04449	0.03145	1.415	0.157	
Racing					
#	**Estimate**	**Std. Error**	**z-value**	**Pr(>|z|)**	
#(Intercept)	-2.13582	0.84976	-2.513	0.012	*
#SPQ- Cog-Per	0.02087	0.02081	1.003	0.316	
#sexM	-1.4326	1.26808	-1.13	0.259	
#SPQ- Cog-Per:sexM	0.04224	0.03193	1.323	0.186	
Construction					
#(Intercept)	0.04839	0.71066	0.068	0.946	
#SPQ- Cog-Per	-0.02133	0.01798	-1.187	0.235	
#sexM	0.53148	1.00207	0.53	0.596	
#SPQ- Cog-Per:sexM	-0.00721	0.02662	-0.271	0.787	
Social Simulation					

#(Intercept)	-0.741634	0.695537	-1.066	0.286	
#SPQ- Cog-Per	0.005027	0.017328	0.29	0.772	
#sexM	-1.31013	1.218963	-1.075	0.282	
#SPQ- Cog-Per:sexM	0.001364	0.032244	0.042	0.966	
Idle					
#(Intercept)	-2.035076	1.117093	-1.822	0.0685	
#SPQ- Cog-Per	-0.005132	0.028084	-0.183	0.855	
#sexM	0.566718	1.567005	0.362	0.7176	
#SPQ- Cog-Per:sexM	-0.014528	0.041949	-0.346	0.7291	
Puzzle					
#(Intercept)	-1.874173	0.863866	-2.17	0.03	*
#SPQ- total	0.020456	0.008978	2.279	0.0227	*
#sexM	-0.532091	1.367703	-0.389	0.6972	
#SPQ- total:sexM	-0.003358	0.0145	-0.232	0.8168	
Action					
#(Intercept)	-2.212225	0.952465	-2.323	0.0202	*
#SPQ- total	0.013994	0.009745	1.436	0.151	
#sexM	2.388551	1.437268	1.662	0.0965	
#SPQ- total:sexM	-0.002346	0.015458	-0.152	0.8794	
Platformer					
#	**Estimate**	**Std. Error**	**z-value**	**Pr(>|z|)**	
#(Intercept)	-1.327172	0.905632	-1.465	0.143	
#SPQ- total	0.00573	0.00935	0.613	0.54	
#sexM	0.605466	1.372321	0.441	0.659	
#SPQ- total:sexM	-0.008726	0.01469	-0.594	0.552	
RPG					
#(Intercept)	-1.717973	1.02738	-1.672	0.0945	
#SPQ- total	0.004286	0.010598	0.404	0.6859	
#sexM	1.290069	1.381488	0.934	0.3504	
#SPQ- total:sexM	0.001096	0.014649	0.075	0.9404	

Strategy					
#	**Estimate**	**Std. Error**	**z-value**	**Pr(>|z|)**	
#(Intercept)	-1.307872	1.185861	-1.103	0.27	
#SPQ- total	-0.005797	0.012448	-0.466	0.641	
#sexM	-0.512669	1.523766	-0.336	0.737	
#SPQ- total:sexM	0.024785	0.016247	1.526	0.127	
Sports					
#(Intercept)	-0.23329	1.13373	-0.206	0.837	
#SPQ- total	-0.01693	0.01215	-1.393	0.164	
#sexM	-0.61372	1.51215	-0.406	0.685	
#SPQ- total:sexM	0.01722	0.01636	1.053	0.292	
Racing					
#(Intercept)	-2.3093	1.05286	-2.193	0.0283	*
#SPQ- total	0.01044	0.01076	0.97	0.3321	
#sexM	-1.2014	1.61185	-0.745	0.4561	
#SPQ- total:sexM	0.01419	0.01679	0.845	0.398	
Construction					
#(Intercept)	-1.210622	0.902417	-1.342	0.18	
#SPQ- total	0.004509	0.009327	0.483	0.629	
#sexM	1.147236	1.302986	0.88	0.379	
#SPQ- total:sexM	-0.008514	0.013905	-0.612	0.54	
Social Simulation					
#(Intercept)	-1.61399	0.884194	-1.825	0.0679	
#SPQ- total	0.011215	0.009108	1.231	0.2182	
#sexM	-0.673131	1.61886	-0.416	0.6776	
#SPQ- total:sexM	-0.006096	0.017282	-0.353	0.7243	
Idle					
#(Intercept)	-2.029095	1.389358	-1.46	0.144	
#SPQ- total	-0.002177	0.014489	-0.15	0.881	
#sexM	-0.776283	2.081821	-0.373	0.709	
#SPQ- total:sexM	0.009389	0.022107	0.425	0.671	

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Table 2.10 Gaming Motivations in relation to AQ-Total, SPQ-Total and SPQ-CogPer scores.

Variables		Scores Mean ± SD (N)			T (df)	p value
Social Interaction						
AQ- Total	F	Y	20.97	± 6.27 (61)	0.67 (116)	0.51
		N	20.32	± 6.48 (146)		
	M	Y	19.13	± 6.11 (76)	-0.71 (136)	0.48
		N	19.90	± 6.68 (68)		
	B	Y	19.50	± 6.22 (137)	-0.34 (300)	0.73
		N	20.19	± 6.53 (214)		
SPQ-Total	F	Y	95.62	± 14.60 (61)	0.40 (129)	0.69
		N	94.69	± 16.86 (146)		
	M	Y	89.68	± 17.03 (76)	-0.13 (141)	0.90
		N	90.04	± 16.19 (68)		
	B	Y	92.33	± 16.21 (137)	-0.49 (297)	0.62
		N	93.22	± 16.76 (214)		
SPQ-CogPer	F	Y	39.31	± 8.10 (61)	0.16 (118)	0.88
		N	39.12	± 8.49 (146)		
	M	Y	34.90	± 8.62 (76)	-0.67 (138)	0.50
		N	35.90	± 9.21 (68)		
	B	Y	36.86	± 8.65 (137)	-1.29 (294)	0.20
		N	38.09	± 8.83 (214)		
Stress Relief						
AQ-Total	F	Y	21.39	± 6.29 (131)	2.62 (155)	0.0099
		N	19.00	± 6.37 (76)		
	M	Y	91.43	± 16.13 (104)	1.80 (67)	0.07
		N	85.75	± 17.25 (40)		
	B	Y	20.65	± 6.25 (235)	2.29 (218)	0.02
		N	18.97	± 6.60 (116)		
SPQ-Total	F	Y	96.17	± 16.42 (131)	1.42 (163)	0.16
		N	92.90	± 15.70 (76)		
	M	Y	91.43	± 16.13 (104)	1.80 (67)	0.08

		N	85.75	± 17.25 (40)		
	B	Y	94.07	± 16.43 (235)	1.94 (228)	0.053
		N	90.43	± 16.53 (116)		
SPQ-CogPer	F	Y	39.26	± 8.61 (131)	0.20 (167)	0.84
		N	39.03	± 7.96 (76)		
	M	Y	36.35	± 8.88 (104)	2.20 (74)	0.03
		N	32.83	± 8.5 (40)		
	B	Y	37.97	± 8.83 (235)	1.10 (234)	0.27
		N	36.89	± 8.63 (116)		
Skill Development						
AQ-Total	F	Y	22.18	± 6.00 (33)	1.73 (47)	0.09
		N	20.20	± 6.46 (174)		
	M	Y	92.90	± 15.25 (50)	1.67 (110)	0.10
		N	88.23	± 17.11 (94)		
	B	Y	21.28	± 5.98 (83)	2.02 (147)	0.045
		N	19.73	± 6.50 (268)		
SPQ-Total	F	Y	98.21	± 15.09 (33)	1.33 (47)	0.20
		N	94.35	± 16.37 (174)		
	M	Y	92.90	± 15.25 (50)	1.67 (110)	0.10
		N	88.23	± 17.11 (94)		
	B	Y	95.01	± 15.32 (83)	1.42 (149)	0.16
		N	92.21	± 16.86 (268)		
SPQ-CogPer	F	Y	40.33	± 8.52 (33)	0.86 (44)	0.40
		N	38.95	± 8.34 (174)		
	M	Y	37.28	± 8.59 (50)	1.92 (103)	0.057
		N	34.35	± 8.92 (94)		
	B	Y	38.49	± 8.64 (83)	1.06 (139)	0.30
		N	37.34	± 8.81 (268)		
Adrenaline Rush						
AQ-Total	F	Y	21.63	± 5.16 (46)	1.55 (93)	0.12
		N	20.19	± 6.70 (161)		
	M	Y	90.40	± 17.93 (58)	0.31 (111)	0.75
		N	89.49	± 15.71 (86)		
	B	Y	37.60	± 8.95 (104)	-0.02 (189)	0.98
		N	37.62	± 8.71 (247)		
SPQ-Total	F	Y	95.87	± 14.21(46)	0.47 (84)	0.64
		N	94.71	± 16.76 (161)		
	M	Y	90.40	± 17.93 (58)	0.31 (111)	0.75
		N	89.49	± 15.71 (86)		

	B	Y	92.82	± 16.54 (104)	-0.04 (194)	0.97
		N	92.89	± 16.55 (247)		
SPQ-CogPer	F	Y	39.41	± 8.21 (46)	0.22 (74)	0.82
		N	39.11	± 8.43 (161)		
	M	Y	36.16	± 9.31 (58)	0.86 (116)	0.39
		N	34.84	± 8.60 (86)		
	B	Y	37.60	± 8.95 (104)	-0.02 (189)	0.98
		N	37.62	± 8.71 (247)		
Escape						
AQ-Total	F	Y	20.89	± 6.66 (116)	0.96 (200)	0.34
		N	20.03	± 6.07 (91)		
	M	Y	19.58	± 6.42 (91)	0.22 (110)	0.83
		N	19.34	± 6.36 (53)		
	B	Y	20.31	± 6.57 (207)	0.78(320)	0.44
		N	19.78	± 6.17 (144)		
SPQ-Total	F	Y	94.66	± 15.99 (116)	-0.31 (190)	0.76
		N	95.36	± 16.54 (91)		
	M	Y	91.90	± 17.27(91)	2.04 (122)	0.04
		N	86.34	± 14.83 (53)		
	B	Y	93.44	± 16.58 (207)	0.78 (309)	0.43
		N	92.04	± 16.47 (144)		
SPQ-CogPer	F	Y	38.31	± 8.55 (116)	-1.70 (198)	0.09
		N	40.28	± 8.03 (91)		
	M	Y	36.13	± 9.07 (91)	1.38 (115)	0.17
		N	34.06	± 8.48 (53)		
	B	Y	37.35	± 8.83 (207)	-0.67 (310)	0.50
		N	37.99	± 8.70 (144)		
Fantasy						
AQ-Total	F	Y	22.27	± 6.16 (49)	2.26 (83)	0.03
		N	19.97	± 6.41 (158)		
	M	Y	20.70	± 6.87 (54)	1.72 (100)	0.09
		N	18.77	± 5.98 (90)		
	B	Y	21.45	± 6.56 (103)	2.52 (183)	0.01
		N	19.53	± 6.27 (248)		
SPQ-Total	F	Y	95.53	± 16.66 (49)	0.27 (78)	0.79
		N	94.79	± 16.10 (158)		
	M	Y	91.17	± 16.33 (54)	0.74 (114)	0.46
		N	89.07	± 16.77 (90)		
	B	Y	93.24	± 16.56 (103)	0.27 (191)	0.79

		N	92.71	± 16.55 (248)		
SPQ-CogPer	F	Y	38.67	± 8.89 (49)	-0.50 (75)	0.65
		N	39.33	± 8.21 (158)		
	M	Y	34.52	± 8.69 (54)	-0.90 (115)	0.37
		N	35.88	± 9.01 (90)		
	B	Y	36.50	± 8.99 (103)	-1.52 (184)	0.13
		N	38.08	± 8.65 (248)		
Customization						
AQ-Total	F	Y	21.90	± 6.55 (58)	1.92 (100)	0.058
		N	19.97	± 6.30 (149)		
	M	Y	20.96	± 5.86 (55)	2.26 (124)	0.03
		N	18.58	± 6.54 (89)		
	B	Y	21.44	± 6.21 (113)	2.77 (227)	0.006
		N	19.45	± 6.41 (238)		
SPQ-Total	F	Y	93.93	± 17.31 (58)	-0.55 (96)	0.58
		N	95.37	± 15.79 (149)		
	M	Y	93.36	± 15.03 (55)	1.42 (108)	0.16
		N	87.69	± 17.20 (89)		
	B	Y	93.66	± 16.17 (113)	0.62 (227)	0.54
		N	92.50	± 16.72 (238)		
SPQ-CogPer	F	Y	38.21	± 8.66 (58)	-1.02 (99)	0.31
		N	39.55	± 8.24 (149)		
	M	Y	36.73	± 9.27 (55)	1.42 (108)	0.16
		N	34.53	± 8.59 (89)		
	B	Y	37.49	± 8.95 (113)	-0.18 (215)	0.85
		N	37.67	± 8.70 (238)		

Sample sizes for Females = 207, Males = 144, and Both Genders = 351

Table 2.11 Multiple regressions of Video Game Motivations in relation to AQ and SPQ subscales

Motivations	Estimate	Std.Error	z value	Pr(>|z|)	Significance
Social Interaction					
#(Intercept)	-1.46381	0.60872	-2.405	0.01618	*
#social	-0.17447	0.05944	-2.935	0.00334	**
#AQ- Detail	0.1348	0.05495	2.453	0.01416	*
#SPQ- Anxiety	0.0934	0.03567	2.618	0.00884	**
#SPQ- Magic	-0.0974	0.03344	-2.913	0.00358	**
#sexM	0.96596	0.2471	3.909	9.26E-05	***
Stress Relief					
#(Intercept)	-0.72755	0.45867	-1.586	0.11269	
#social	0.13741	0.04945	2.779	0.00546	**
#SPQ- Percep	0.07582	0.03783	2.004	0.04503	*
#sexM	0.53779	0.24303	2.213	0.02691	*
Skill Development					
#(Intercept)	-4.64888	0.83445	-5.571	2.53E-08	***
#AQ- Switch	-0.13525	0.08319	-1.626	0.10399	
#AQ- Detail	0.20253	0.06588	3.074	0.00211	**
#SPQ- Ideas	0.06224	0.03191	1.951	0.0511	
#SPQ- Anxiety	0.09324	0.04058	2.297	0.02159	*
#sexM	1.38235	0.28588	4.836	1.33E-06	***
Adrenaline Rush					
#(Intercept)	-1.16298	0.51493	-2.259	0.023914	*
#AQ- Switch	-0.16016	0.07058	-2.269	0.02325	*
#AQ- Detail	0.11838	0.05695	2.079	0.037647	*
#AQ- Comm	0.16872	0.06234	2.706	0.0068	**
#AQ- Imag	-0.1774	0.08315	-2.133	0.032888	*
#sexM	0.89758	0.24615	3.646	0.000266	***
Escape					
#(Intercept)	0.11754	0.52936	0.222	0.8243	
#SPQ- Constrict	-0.04482	0.0244	-1.837	0.0663	

#SPQ- Eccentric	0.13206	0.03339	3.955	7.65E-05	***
#SPQ- Magic	-0.05827	0.03092	-1.885	0.0595	
#sexM	0.182	0.2356	0.773	0.4398	
Fantasy					
#(Intercept)	-1.48079	0.50749	-2.918	0.00352	**
#social	0.10662	0.05079	2.099	0.03579	*
#SPQ- Eccentric	0.05627	0.0343	1.64	0.10095	
#SPQ- Magic	-0.07812	0.03523	-2.217	0.02661	*
#sexM	0.57983	0.25422	2.281	0.02256	*
Customization					
#(Intercept)	-1.99995	0.40449	-4.944	7.64E-07	***
#AQ- Detail	0.11274	0.05411	2.084	0.0372	*
#AQ- Comm	0.12304	0.05286	2.328	0.0199	*
#sexM	0.50972	0.23537	2.166	0.0303	*
AQ-Total, SPQ-Total, SPQ-CogPer and Video Game Motivations					
Social Interaction					
#(Intercept)	-1.19859	0.51878	-2.31	0.0209	*
#AQ- total	0.01578	0.02387	0.661	0.5084	
#sexM	1.68097	0.75021	2.241	0.025	*
#AQ- total:sexM	-0.0348	0.03558	-0.978	0.3279	
Stress Relief					
#(Intercept)	-0.67564	0.49225	-1.373	0.1699	
#AQ- total	0.06044	0.02365	2.556	0.0106	*
#sexM	1.23751	0.77008	1.607	0.1081	
#AQ- total:sexM	-0.04006	0.03772	-1.062	0.2882	
Skill Development					
#(Intercept)	-2.696705	0.683938	-3.943	8.05E-05	***
#AQ- total	0.048813	0.030057	1.624	0.104	
#sexM	1.159698	0.90512	1.281	0.2	
#AQ- total:sexM	-0.003008	0.041232	-0.073	0.942	
Adrenaline Rush					

#(Intercept)	-1.99021	0.58557	-3.399	0.000677	***
#AQ- total	0.03527	0.02633	1.339	0.18049	
#sexM	2.07825	0.80111	2.594	0.009481	**
#AQ- total:sexM	-0.06012	0.03766	-1.596	0.110383	
Escape					
#(Intercept)	-0.18713	0.4712	-0.397	0.691	
#AQ- total	0.02101	0.02204	0.953	0.341	
#sexM	0.61061	0.72888	0.838	0.402	
#AQ- total:sexM	-0.01499	0.03501	-0.428	0.668	
Fantasy					
#(Intercept)	-2.373863	0.592879	-4.004	6.23E-05	***
#AQ- total	0.056982	0.026244	2.171	0.0299	*
#sexM	0.897916	0.831424	1.08	0.2802	
#AQ- total:sexM	-0.008086	0.038263	-0.211	0.8326	
Customization					
#(Intercept)	-1.93899	0.54933	-3.53	0.000416	***
#AQ- total	0.04756	0.02468	1.927	0.053986	
#sexM	0.25863	0.80655	0.321	0.748468	
#AQ- total:sexM	0.01306	0.03742	0.349	0.727016	
Social Interaction					
#	Estimate	Std. Error	z value	Pr(>|z|)	
#(Intercept)	-0.982868	0.734704	-1.338	0.181	
#SPQ- CogPer	0.002809	0.018309	0.153	0.878	
#sexM	1.547661	1.008401	1.535	0.125	
#SPQ-CogPer:sexM	-0.015623	0.026328	-0.593	0.553	
Stress Relief					
#	Estimate	Std. Error	z value	Pr(>|z|)	
#(Intercept)	0.413305	0.690974	0.598	0.55	
#SPQ- CogPer	0.003351	0.017277	0.194	0.846	
#sexM	-1.066683	1.034617	-1.031	0.303	
#SPQ-CogPer:sexM	0.043189	0.02804	1.54	0.123	

Skill Development					
#(Intercept)	-2.4647	0.95275	-2.587	0.00968	**
#SPQ- CogPer	0.02023	0.02327	0.869	0.38462	
#sexM	0.47192	1.21742	0.388	0.69828	
#SPQ-CogPer:sexM	0.01779	0.0309	0.576	0.56489	
Adrenaline Rush					
#(Intercept)	-1.426867	0.808792	-1.764	0.0777	
#SPQ- CogPer	0.004435	0.020112	0.22	0.8255	
#sexM	0.434307	1.074938	0.404	0.6862	
#SPQ-CogPer:sexM	0.012431	0.02787	0.446	0.6556	
Escape					
#(Intercept)	1.37239	0.69288	1.981	0.0476	*
#SPQ- CogPer	-0.02874	0.0172	-1.671	0.0947	
#sexM	-1.77272	0.99445	-1.783	0.0747	
#SPQ-CogPer:sexM	0.05556	0.02628	2.114	0.0345	*
Fantasy					
#	Estimate	Std. Error	z value	Pr(>|z|)	
#(Intercept)	-0.804764	0.775779	-1.037	0.3	
#SPQ- CogPer	-0.009384	0.019529	-0.481	0.631	
#sexM	0.907813	1.050212	0.864	0.387	
#SPQ-CogPer:sexM	-0.008057	0.027669	-0.291	0.771	
Customization					
#(Intercept)	-0.1958	0.7316	-0.268	0.789	
#SPQ- CogPer	-0.01923	0.01852	-1.038	0.2992	
#sexM	-1.29476	1.03134	-1.255	0.2093	
#SPQ-CogPer:sexM	0.04756	0.02703	1.76	0.0785	
Social Interaction					

#(Intercept)	-1.213661	0.917	-1.324	0.186	
#SPQ- total	0.003583	0.009483	0.378	0.706	
#sexM	1.443336	1.301267	1.109	0.267	
#SPQ- total:sexM	-0.004901	0.013857	-0.354	0.724	
Stress Relief					
#	Estimate	Std. Error	z value	Pr(>|z|)	
#(Intercept)	-0.642217	0.858115	-0.748	0.454	
#SPQ- total	0.012551	0.008983	1.397	0.162	
#sexM	-0.262733	1.335065	-0.197	0.844	
#SPQ- total:sexM	0.008444	0.01459	0.579	0.563	
Skill Development					
#(Intercept)	-3.138954	1.208632	-2.597	0.0094	**
#SPQ- total	0.01533	0.012227	1.254	0.2099	
#sexM	0.920959	1.578383	0.583	0.5596	
#SPQ- total:sexM	0.002185	0.016411	0.133	0.8941	
Adrenaline Rush					
#(Intercept)	-1.67989	1.011333	-1.661	0.0967	
#SPQ- total	0.004482	0.010431	0.43	0.6674	
#sexM	0.986395	1.382736	0.713	0.4756	
#SPQ- total:sexM	-0.001151	0.014661	-0.079	0.9374	
Escape					
#(Intercept)	0.500473	0.836873	0.598	0.5498	
#SPQ- total	-0.002713	0.00868	-0.313	0.7546	
#sexM	-1.804932	1.279633	-1.411	0.1584	
#SPQ- total:sexM	0.023409	0.013824	1.693	0.0904	
Fantasy					
#(Intercept)	-1.44145	0.983138	-1.466	0.143	
#SPQ- total	0.002844	0.010166	0.28	0.78	
#sexM	0.23317	1.377424	0.169	0.866	
#SPQ- total:sexM	0.004895	0.014616	0.335	0.738	
Customization					

#(Intercept)	-0.424867	0.913075	-0.465	0.642
#SPQ- total	-0.005479	0.009538	-0.574	0.566
#sexM	-2.002969	1.358895	-1.474	0.14
#SPQ- total:sexM	0.026974	0.014456	1.866	0.062

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Table 2.12 Pearson Correlations for Reaction Times and Targeting Times in relation to AQ and SPQ scales

	Reaction Time (ms)	**Targeting Time (ms)**
Females	**N = 144**	**N = 195**
AQ: Social	-0.16 [0.02]	0.19 [0.006]
AQ- Switch	-0.09	0.06
AQ- Detail	-0.13 [0.06]	0.04
AQ- Comm	-0.10	0.09
AQ- Imag	-0.00	-0.02
AQ: Total	-0.17 [0.01]	0.13 [0.06]
SPQ- Ideas	-0.08	-0.05
SPQ- Constrict	-0.07	-0.04
SPQ- Eccentric	-0.20 [0.0042]	0.09
SPQ- Anxiety	-0.16 [0.02]	0.14 [0.05]
SPQ- Magic	-0.07	-0.14 [0.06]
SPQ- Speech	-0.03	-0.05
SPQ- Percep	-0.05	-0.09
SPQ- Interpersonal	-0.13	0.05
Disorganized	-0.15 [0.03]	0.03
SPQ- Cog-Per	-0.10	-0.12
SPQ- Total	-0.16 [0.02]	-0.03
Males	**N = 144**	**N = 140**
AQ- Social	-0.01	0.04
AQ- Switch	0.02	-0.03
AQ- Detail	0.05	0.08
AQ- Comm	-0.02	0.04
AQ- Imag	-0.05	-0.02
AQ- Total	0.00	0.04
SPQ- Ideas	-0.04	-0.06

SPQ- Constrict	-0.10	0.15
SPQ- Eccentric	0.04	-0.01
SPQ- Anxiety	-0.09	0.13
SPQ- Magic	0.32 [8.86E-05]	-0.29 [0.001]
SPQ- Speech	-0.02	0.07
SPQ- Percep	0.07	-0.12
SPQ- Interpersonal	-0.12	0.17 [0.05]
SPQ- Disorganized	0.01	0.03
SPQ- Cog- Per	0.13	-0.20 [0.03]
SPQ- Total	0.02	-0.02
Both Genders	**N = 348**	**N = 335**
AQ- Social	-0.07	0.09
AQ- Switch	-0.03	0.00
AQ- Detail	-0.05	0.03
AQ- Comm	-0.06	0.06
AQ- Imag	-0.02	-0.02
AQ- Total	-0.08	0.06
SPQ- Ideas	-0.03	-0.09
SPQ- Constrict	-0.10	0.06
SPQ- Eccentric	-0.11 [0.04]	0.06
SPQ- Anxiety	-0.08	0.07
SPQ- Magic	0.14 [0.01]	-0.26 [1.17E-06]
SPQ- Speech	-0.00	-0.04
SPQ- Percep	0.02	-0.13 [0.02]
SPQ- Interpersonal	-0.11 [0.04]	0.08
SPQ- Disorganized	-0.07	0.02
SPQ- Cog-Percep	0.05	-0.21 [0.00013]
SPQ- Total	-0.05	-0.07

P values under 0.05 or near are shown in brackets.

Table 2.13 Multiple regressions of Reaction Times and Targeting Times in relation to AQ and SPQ subscales

Correlation of Targeting time to Reaction Time

#	Estimate	Std. Error	t value	Pr(>|t|)	Significance
#(Intercept)	79.7729	58.5319	1.363	0.1738	
#rt	-0.847	0.2028	-4.176	3.80E-05	***
#sexM	246.6696	87.0867	2.832	0.0049	**
#rt:sexM	-0.6986	0.3107	-2.249	0.0252	*

Multiple regression ** of Reaction times in relation to AQ and SPQ subscales

#	Estimate	Std. Error	t value	Pr(>|t|)	Significance
#(Intercept)	302.89688	13.19073	22.963	< 2.00E-16	***
#AQ - Social	-0.39209	1.12491	-0.349	0.727644	
#AQ- Switch	0.59866	1.14814	0.521	0.602425	
#AQ- Detail	-1.08063	0.84608	-1.277	0.202412	
#AQ- Comm	0.39686	1.19042	0.333	0.73906	
#AQ- Imag	-0.22032	1.24019	-0.178	0.859104	
#SPQ- Ideas	-0.25072	0.51144	-0.49	0.624304	
#SPQ- Constrict	-0.15577	0.44731	-0.348	0.727879	
#SPQ- Eccentric	-0.68387	0.604	-1.132	0.258347	
#SPQ- Anxiety	-0.79811	0.62891	-1.269	0.20531	
#SPQ- Magic	0.91986	0.55541	1.656	0.098622	
#SPQ- Speech	0.02644	0.67003	0.039	0.968543	
#SPQ- Percep	0.3285	0.70156	0.468	0.639913	
#sexM	-14.48138	4.07952	-3.55	0.000441	***

Multiple Regression of Targeting times in relation to AQ and SPQ subscales

#	Estimate	Std. Error	t value	Pr(>|t|)	Significance
#(Intercept)	-145.9983	39.9941	-3.65	0.000305	***
#social	2.8928	3.4525	0.838	0.402711	
#AQ- Switch	-2.6727	3.4656	-0.771	0.44114	
#AQ- Detail	4.5847	2.607	1.759	0.079592	
#AQ- Comm	0.1444	3.6509	0.04	0.968478	
#AQ- Imag	-2.717	3.8086	-0.713	0.476125	
#SPQ- Ideas	-1.1812	1.5423	-0.766	0.44433	

#SPQ- Constrict	-0.3094	1.3722	-0.225	0.821736	
#SPQ- Eccentric	1.018	1.8482	0.551	0.582138	
#SPQ- Anxiety	3.3686	1.9045	1.769	0.077888	
#SPQ- Magic	-4.6986	1.6803	-2.796	0.005481	**
#SPQ- Speech	0.7816	2.0492	0.381	0.703152	
#SPQ- Percep	-2.5869	2.1137	-1.224	0.221887	
#sexM	65.4571	12.452	5.257	2.68E-07	***

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Table 2.14 Pearson Correlations of Video Game Usage in relation to Reaction Times (RT) and Targeting Times (RT)

Video Game Usage Variable	Wkday (h)		Wkend (h)		Self report frequency		Self report usage		Self report spare time	
	r	p	r	p	r	p	r	p	r	p
Females										
RT	-0.06	0.38	-0.11	0.11	-0.18	6.16E-04	0.11	0.11	-0.09	0.22
TT	0.33	2.11E-06	0.34	1.30E-06	0.29	4.32E-05	-0.21	0.004	0.32	5.2E-06
Males										
RT	-0.23	0.006	-0.21	0.01	-0.23	0.005	0.15	0.07	-0.20	0.01
TT	0.29	0.0005	0.30	0.0003	0.26	0.002	-0.29	0.0004	0.27	0.001
Both genders										
RT	-0.21	6.19E-05	-0.23	1.18E-05	0.19	4.16E-04	0.19	4.16E-04	-0.21	5.58E-05
TT	0.39	8.86E-14	0.41	5.55E-15	0.38	1.06E-12	-0.32	1.29E-09	0.39	2.28E-13

r = Pearson correlation. N=195 (females), 140 (males), 335 (both genders).

Wkday = weekday, wkend = weekend

Table 2.15 Stepwise regression analyses for AQ and SPQ subscales in relation to Video Game Usage Variables

Usage Self Report to AQ/SPQ and Reaction time and Targeting Time

#	Estimate	Std. Error	t value	Pr(>|t|)	Significance
#(Intercept)	3.7781795	0.310519	12.167	< 2.00E-16	***
#AQ- Detail	-0.0647273	0.0329048	-1.967	0.05	*
#SPQ- Eccentric	-0.0410315	0.0190243	-2.157	0.0317	*
#sexM	-0.8282184	0.1541396	-5.373	1.47E-07	***
#targett	-0.0030079	0.0006893	-4.363	1.72E-05	***
#Residual standard error: 1.315 on 328 degrees of freedom					
#Multiple R-squared: 0.1971,	Adjusted R-squared: 0.1873				
#F-statistic: 20.13 on 4 and 328 DF, p-value: 7.714e-15					

Frequency Self Report to AQ/SPQ and Reaction Time and Targeting Time

#(Intercept)	4.4749143	0.4736514	9.448	< 2.00E-16	***
#social	0.0670621	0.0430508	1.558	0.1203	
#SPQ- Ideas	-0.0396469	0.0232306	-1.707	0.0888	
#SPQ- Eccentric	0.0463542	0.0293338	1.58	0.115	
#sexM	1.8339238	0.2169792	8.452	9.58E-16	***
#targett	0.0044864	0.0009647	4.65	4.81E-06	***
#Residual standard error: 1.824 on 327 degrees of freedom					
#Multiple R-squared: 0.313,	Adjusted R-squared: 0.3025				
#F-statistic: 29.8 on 5 and 327 DF, p-value: < 2.2e-16					

Weekday Time (h) to AQ/SPQ and Reaction Time and Targeting Time

#(Intercept)	0.9345684	0.5162202	1.81	0.0712	
#AQ- Detail	0.0673087	0.0353225	1.906	0.0576	
#SPQ- Constrict	-0.0296439	0.0169008	-1.754	0.0804	
#SPQ- Anxiety	0.0319666	0.0209799	1.524	0.1286	
#SPQ- Speech	0.0522258	0.0255035	2.048	0.0414	*
#SPQ- Percep	-0.043023	0.026713	-1.611	0.1082	
#sexM	1.1057321	0.1713112	6.455	3.95E-10	***
#targett	0.0040805	0.0007478	5.457	9.64E-08	***
#Residual standard error: 1.403 on 325 degrees of freedom					
#Multiple R-squared: 0.2645,	Adjusted R-squared: 0.2486				
#F-statistic: 16.69 on 7 and 325 DF, p-value: < 2.2e-16					

Weekend Time (h) to AQ/SPQ and Reaction Time and Targeting Time

#(Intercept)	1.271434	0.556319	2.285	0.0229	*
#AQ- Comm	0.097316	0.051329	1.896	0.0589	
#SPQ- Speech	0.075818	0.035472	2.137	0.0333	*
#sexM	1.745328	0.238275	7.325	1.87E-12	***
#targett	0.006407	0.001061	6.037	4.24E-09	***
#Residual standard error: 2.025 on 328 degrees of freedom					
#Multiple R-squared: 0.2948,	Adjusted R-squared: 0.2s862				
#F-statistic: 34.27 on 4 and 328 DF, p-value: < 2.2e-16					

Spare Time Self Report to AQ/SPQ and Reaction Time and Targeting Time

#	Estimate	Std. Error	t value	Pr(>|t|)	
#(Intercept)	2.1384391	0.2301692	9.291	< 2.00E-16	***
#SPQ- Eccentric	0.0470214	0.0149182	3.152	0.00177	**
#SPQ- Magic	-0.0353157	0.0157008	-2.249	0.02516	*
#sexM	0.7533648	0.1222097	6.165	2.07E-09	***
#targett	0.0027803	0.0005501	5.055	7.18E-07	***
#Residual standard error: 1.028 on 328 degrees of freedom					
#Multiple R-squared: 0.2811,	Adjusted R-squared: 0.2723				
#F-statistic: 32.06 on 4 and 328 DF, p-value: < 2.2e-16					

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Table 2.16 ANCOVAs of Reaction Time and Video Game Usage in relation to Video Game Usage variables

Reaction Time and Video Game Usage on Video Game Usage Variables					
#	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**	**Sig.**
Usage Self Report					
#(Intercept)	1.968349	0.620888	3.17	0.00166	**
#rt	0.005145	0.002143	2.401	0.01688	*
#sexM	-0.920412	0.152408	-6.039	4.01E-09	***
Frequency Self Report					
#(Intercept)	5.092265	0.857797	5.936	7.10E-09	***
#rt	-0.005014	0.00296	-1.694	0.0912	.
#sexM	2.199312	0.210561	10.445	< 2.00E-16	***
Weekday time (h)					
#(Intercept)	2.590949	0.665821	3.891	0.00012	***
#rt	-0.006174	0.002298	-2.687	0.00756	**
#sexM	1.251552	0.163437	7.658	1.92E-13	***
Weekend time (h)					
#(Intercept)	4.388712	0.956443	4.589	6.26E-06	***
#rt	-0.009851	0.003301	-2.984	0.00304	**
#sexM	2.035239	0.234776	8.669	< 2.00E-16	***
Self Report Spare Time					
#(Intercept)	3.092605	0.486386	6.358	6.47E-10	***
#rt	-0.004399	0.001679	-2.62	0.00917	**
#sexM	1.004191	0.119392	8.411	1.09E-15	***
ANCOVA of Targeting Time and Video Game Usage on Video Game Usage Variables					
Self Report Frequency					
#(Intercept)	4.5429709	0.2048749	22.174	< 2.00E-16	***
#targett	0.0048992	0.0009614	5.096	5.84E-07	***
#sexM	1.8295254	0.2145574	8.527	5.39E-16	***
Weekday Time (h)					

#(Intercept)	1.5788947	0.1577565	10.008	< 2e-16	***
#targett	0.0044279	0.0007403	5.981	5.73e-09	***
#sexM	0.9709525	0.1652122	5.877	1.02e-08	***
Weekend Time (h)					
#(Intercept)	2.679045	0.227408	11.781	< 2.00E-16	***
#targett	0.006582	0.001067	6.168	2.02E-09	***
#sexM	1.672245	0.238156	7.022	1.24E-11	***
Spare Time Self Report					
#(Intercept)	2.38157	0.116359	20.468	< 2.00E-16	***
#targett	0.003124	0.000546	5.722	2.36E-08	***
#sexM	0.810637	0.121858	6.652	1.19E-10	***
Usage Self Report					
#(Intercept)	2.9408571	0.1476548	19.92	< 2.00E-16	
#targett	-0.0031597	0.0006929	-4.56	7.20E-06	***
#sexM	-0.814947	0.154633	-5.27	2.46E-07	***

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001
Sig. = significance

Table 2.17 Analysis of Reaction Time and Targeting Time in relation to Video Game Genre preferences

Variables		Scores			T (df)	p value
		Mean ± SD (N)				
Reaction time (ms)						
Action	F	Y	282.93	± 34.32 (59)	-0.89 (106)	0.38
		N	287.64	± 33.82 (145)		
	M	Y	268.00	± 31.45 (111)	-1.85 (43)	0.07
		N	283.01	± 43.31 (33)		
	B	Y	273.19	± 33.15 (170)	-3.68 (346)	2.55E-04
		N	286.78	± 35.68 (178)		
Platformer	F	Y	282.39	± 31.10 (65)	-1.17 (140)	0.24
		N	288.09	± 35.16 (139)		
	M	Y	273.96	± 31.97 (39)	0.55 (76)	0.58
		N	270.51	± 36.07 (105)		
	B	Y	279.23	± 31.54 (104)	-0.33 (224)	0.74
		N	280.53	± 36.54 (244)		
Puzzle	F	Y	284.19	± 35.91 (105)	-0.91 (201)	0.36
		N	288.49	± 31.76 (99)		
	M	Y	269.56	± 32.79 (43)	-0.44 (86)	0.66
		N	272.24	± 35.94 (101)		
	B	Y	279.94	± 35.55 (148)	-0.09 (313)	0.93
		N	280.29	± 34.82 (200)		
RPG	F	Y	277.29	± 23.28 (44)	-2.54 (106)	0.01
		N	288.75	± 36.00 (160)		
	M	Y	265.63	± 34.55 (74)	-2.08 (142)	0.04
		N	277.59	± 34.52 (70)		
	B	Y	269.97	± 31.24 (118)	-4.13 (266)	0.00005
		N	285.35	± 35.85 (230)		
Strategy	F	Y	276.22	± 28.82 (28)	-1.93 (40)	0.06
		N	287.88	± 34.49 (176)		
	M	Y	266.79	± 32.26 (68)	-1.53 (142)	0.13
		N	275.60	± 36.87 (76)		
	B	Y	269.54	± 31.45 (96)	-3.74 (193)	0.0002
		N	284.17	± 35.60 (252)		
Sports	F	Y	281.11	± 31.06 (29)	-0.95 (40)	0.35
		N	287.13	± 34.41 (175)		
	M	Y	269.91	± 31.29 (44)	-0.37 (95)	0.71
		N	272.12	± 36.55 (100)		

	B	Y	274.36	± 31.47 (73)	-1.71 (126)	0.09
		N	281.67	± 35.87 (275)		
Racing	F	Y	281.09	± 31.36 (43)	-1.19 (72)	0.24
		N	287.66	± 34.57 (161)		
	M	Y	271.32	± 27.60 (32)	-0.03 (66)	0.98
		N	271.48	± 36.87 (112)		
	B	Y	276.92	± 30.02 (75)	-1.00 (139)	0.32
		N	281.02	± 36.35 (273)		
Construction	F	Y	280.34	± 25.27 (64)	-1.95 (172)	0.053
		N	288.99	± 37.01 (140)		
	M	Y	268.29	± 28.74 (57)	-0.93 (139)	0.35
		N	273.51	± 38.48 (87)		
	B	Y	274.66	± 27.51 (121)	-2.36 (316)	0.02
		N	283.06	± 38.25 (227)		
Social Simulation	F	Y	287.22	± 37.06 (75)	0.29 (138)	0.77
		N	285.73	± 32.14 (129)		
	M	Y	267.78	± 31.44 (20)	-0.55 (27)	0.59
		N	272.03	± 35.55 (124)		
	B	Y	283.13	± 36.67 (95)	0.95 (160)	0.35
		N	279.02	± 34.47 (253)		
Idle	F	Y	277.91	± 30.91 (20)	-1.26 (24)	0.22
		N	287.19	± 34.22 (184)		
	M	Y	256.62	± 20.81 (15)	-2.66 (25)	0.01
		N	273.17	± 35.88 (129)		
	B	Y	268.78	± 28.75 (35)	-2.40 (46)	0.02
		N	281.41	± 35.53 (313)		
Targeting Time (ms)						
Action	F	Y	-137.79	± 93.43 (57)	2.37 (113)	0.02
		N	-173.65	± 101.37 (138)		
	M	Y	-89.49	± 109.95 (109)	0.78 (47)	0.44
		N	-107.73	± 115.64(31)		
	B	Y	-106.08	± 106.79 (166)	4.75 (333)	3.00E-06
		N	-161.56	± 106.88 (169)		
Platformer	F	Y	-149.74	± 85.98 (62)	1.38 (144)	0.17
		N	-169.43	± 105.93 (133)		
	M	Y	-87.77	± 105.53 (39)	0.39 (74)	0.70
		N	-95.75	± 113.57 (101)		
	B	Y	-125.81	± 98.29 (101)	0.96 (220)	0.34
		N	-137.63	± 115.02 (234)		

Puzzle	F	Y	-158.50	± 103.94 (101)	0.68 (193)	0.50
		N	-168.18	± 98.37 (94)		
	M	Y	-82.28	± 117.54 (42)	0.76 (72)	0.45
		N	-98.35	± 108.45 (98)		
	B	Y	-136.11	± 113.18 (143)	-0.29 (298)	0.77
		N	-132.54	± 108.26 (192)		
RPG	F	Y	-103.12	± 86.54 (43)	5.01 (75)	3.57E-06
		N	-180.15	± 97.49 (152)		
	M	Y	-70.55	± 94.43 (71)	2.52 (128)	0.01
		N	-117.17	± 122.15 (69)		
	B	Y	-82.84	± 92.52 (114)	6.83 (264)	5.88E-11
		N	-160.49	± 109.50 (221)		
Strategy	F	Y	-127.35	± 85.08 (26)	2.24 (37)	0.03
		N	-168.68	± 101.45 (169)		
	M	Y	-72.66	± 107.46 (66)	2.13 (137)	0.03
		N	-112.14	± 111.64 (74)		
	B	Y	-88.11	± 104.16 (92)	4.92 (169)	2.02E-06
		N	-151.46	± 107.63 (243)		
Sports	F	Y	-161.60	± 109.97 (26)	0.08 (32)	0.94
		N	-163.41	± 98.99 (169)		
	M	Y	-97.12	± 115.55 (44)	-0.25 (80)	0.80
		N	-91.88	± 109.54 (96)		
	B	Y	-121.07	± 116.99 (70)	1.06 (102)	0.29
		N	-137.50	± 108.35 (265)		
Racing	F	Y	-155.49	± 82.51 (43)	0.65 (84)	0.52
		N	-165.34	± 104.83 (152)		
	M	Y	-94.13	± 111.02 (31)	-0.03 (49)	0.97
		N	-93.36	± 111.60 (109)		
	B	Y	-129.79	± 99.55 (74)	0.41 (131)	0.69
		N	-135.28	± 113.23 (261)		
Construction	F	Y	-138.17	± 88.28 (62)	2.55 (138)	0.01
		N	- 174.82	± 103.59 (133)		
	M	Y	-71.91	± 103.27 (55)	1.91 (124)	0.058
		N	-107.52	± 114.26 (85)		
	B	Y	-107.02	± 100.83 (117)	3.45 (261)	6.51E-04
		N	-148.58	± 112.53 (218)		
Social simulation	F	Y	-140.47	± 95.89 (74)	2.54 (160)	0.01
		N	-177.05	± 100.66 (121)		
	M	Y	-47.98	± 99.34 (19)	2.11 (26)	0.04

		N	-100.68	± 111.49 (121)		
	B	Y	-121.58	± 103.11 (93)	1.34 (181)	0.18
		N	-138.86	± 112.69 (242)		
Idle	F	Y	-108.09	± 84.93 (20)	3.00 (25)	0.006
		N	-169.46	± 100.11 (175)		
	M	Y	-56.05	± 89.38 (15)	1.67 (20)	0.11
		N	-98.03	± 112.86 (125)		
	B	Y	-85.79	± 89.46 (35)	3.28 (47)	0.002
		N	-139.70	± 111.17 (300)		

Table 2.18 ANCOVAs of Reaction Time and Targeting Times in relation to Video Game genre preferences (analyzed without interaction terms)

Reaction Time (ms) with Video Game Genres					
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**	**Significance**
Puzzle					
#(Intercept)	0.7251463	0.2195374	3.303	0.00106	**
#rt	-0.0007351	0.0007577	-0.97	0.33263	
#sexM	-0.2269995	0.0538892	-4.212	3.23E-05	***
Action					
#(Intercept)	0.6949461	0.1991283	3.49	0.000546	***
#rt	-0.0014173	0.0006872	-2.062	0.03993	*
#sexM	0.4605932	0.0488795	9.423	2.00E-16	***
Platformer					
#(Intercept)	0.4269376	0.2080752	2.052	0.0409	*
#rt	-0.0003783	0.0007181	-0.527	0.5986	
#sexM	-0.0534066	0.0510757	-1.046	0.2965	
RPG					
#(Intercept)	0.7945085	0.2024794	3.924	0.000105	***
#rt	-0.0020219	0.0006988	-2.893	0.004053	**
#sexM	0.2682088	0.0497021	5.396	1.27E-07	***
Strategy					
#(Intercept)	0.556261	0.187759	2.963	0.00326	**
#rt	-0.001464	0.000648	-2.259	0.02453	*
#sexM	0.313255	0.046089	6.797	4.71E-11	***
Sports					
#(Intercept)	0.2943877	0.1815429	1.622	0.105805	
#rt	-0.0005318	0.0006265	-0.849	0.396625	
#sexM	0.1555103	0.0445628	3.49	0.000546	***
Racing					
#(Intercept)	0.3696849	0.1870099	1.977	0.0489	*
#rt	-0.0005551	0.0006454	-0.86	0.3904	
#sexM	0.0032039	0.0459048	0.07	0.9444	

Construction					
#(Intercept)	0.706017	0.215009	3.284	0.00113	**
#rt	-0.00137	0.000742	-1.847	0.06565	.
#sexM	0.06178	0.052778	1.171	0.24258	
Social Simulation					
#(Intercept)	3.70E-01	1.96E-01	1.883	0.0606	
#rt	-6.37E-06	6.77E-04	-0.009	0.9925	
#sexM	-2.29E-01	4.82E-02	-4.75	2.98E-06	***
Idle					
#(Intercept)	0.371175	0.1361327	2.727	0.00673	**
#rt	-0.0009541	0.0004698	-2.031	0.04305	*
#sexM	-0.0080261	0.0334161	-0.24	0.81033	
Targeting Time (ms) with Video Game Genres					
Puzzle					
#(Intercept)	0.5599985	0.0539107	10.388	< 2.00E-16	***
#targett	0.0002577	0.000253	1.019	0.309	
#sexM	-0.2358953	0.0564586	-4.178	3.76E-05	***
Action					
#(Intercept)	0.3763286	0.0486922	7.729	1.30E-13	***
#targett	0.0005149	0.0002285	2.254	0.0249	*
#sexM	0.4504042	0.0509934	8.833	< 2.00E-16	***
Platformer					
#(Intercept)	0.3650271	0.0511655	7.134	6.14E-12	***
#targett	0.0002885	0.0002401	1.202	0.23	
#sexM	-0.05947	0.0535836	-1.11	0.268	
RPG					
#(Intercept)	0.4081728	0.0487543	8.372	1.61E-15	***
#targett	0.0011501	0.0002288	5.027	8.17E-07	***
#sexM	0.206538	0.0510585	4.045	6.51E-05	***
Strategy					
#(Intercept)	0.2361688	0.0457106	5.167	4.12E-07	***
#targett	0.0006302	0.0002145	2.938	0.00353	**

#sexM	0.2942057	0.0478709	6.146	2.28E-09	***
Sports					
#	Estimate	Std. Error	t value	Pr(>|t|)	
#(Intercept)	1.28E-01	4.44E-02	2.888	0.00413	**
#targett	-3.21E-05	2.08E-04	-0.154	0.8777	
#sexM	1.83E-01	4.65E-02	3.943	9.81E-05	***
Racing					
#(Intercept)	2.34E-01	4.64E-02	5.053	7.20E-07	***
#targett	8.50E-05	2.18E-04	0.39	0.696	
#sexM	-5.00E-03	4.86E-02	-0.103	0.918	
Construction					
#(Intercept)	0.4399368	0.0524321	8.391	1.41E-15	***
#targett	0.0007476	0.000246	3.039	0.00257	**
#sexM	0.0228447	0.0549101	0.416	0.67765	
Social Simulation					
#(Intercept)	0.4928324	0.0475551	10.363	< 2.00E-16	***
#targett	0.0006947	0.0002232	3.113	0.00201	**
#sexM	-0.2921479	0.0498026	-5.866	1.08E-08	***
Idle					
#(Intercept)	0.1766673	0.0337928	5.228	3.04E-07	***
#targett	0.0004542	0.0001586	2.864	0.00445	**
#sexM	-0.027048	0.0353898	-0.764	0.44524	

Table 2.19 T-tests of Reaction and Targeting times in relation to Video Game Motivations (Welch t-tests)

Variables		Scores			T (df)	p value
		Mean ± SD (N)				
Reaction Time (ms)						
Social Interaction	F	Y	287.31	± 35.32 (60)	0.28 (105)	0.78
		N	285.84	± 33.47 (144)		
	M	Y	263.31	± 32.63 (76)	-3.02 (137)	0.003
		N	280.53	± 35.41 (68)		
	B	Y	273.90	± 35.78 (136)	-2.65 (278)	0.01
		N	284.14	± 34.11 (212)		
Stress Relief	F	Y	284.20	± 32.21 (129)	-1.11 (139)	0.27
		N	289.85	± 36.69 (75)		
	M	Y	271.32	± 36.85 (104)	-0.07 (87)	0.94
		N	271.76	± 29.80 (40)		
	B	Y	278.45	± 34.88 (233)	-1.27 (224)	0.20
		N	283.56	± 35.39 (115)		
Skill Development	F	Y	286.80	± 35.22 (33)	0.09 (44)	0.93
		N	286.18	± 33.80 (171)		
	M	Y	260.55	± 29.08 (50)	-2.99 (121)	0.003
		N	277.23	± 36.51 (94)		
	B	Y	270.99	± 34.01 (83)	-2.79 (141)	0.01
		N	283.00	± 34.98 (265)		
Adrenaline Rush	F	Y	288.97	± 27.96 (45)	0.69 (88)	0.49
		N	285.52	± 35.50 (159)		
	M	Y	269.35	± 37.33 (58)	-0.58 (113)	0.57
		N	272.85	± 33.37 (86)		
	B	Y	277.92	± 34.81 (103)	-0.77 (194)	0.44
		N	281.07	± 35.22 (245)		
Escape	F	Y	285.44	± 31.05 (116)	-0.39 (167)	0.69
		N	287.38	± 37.58 (88)		
	M	Y	271.31	± 32.18 (91)	-0.06 (92)	0.96
		N	271.67	± 39.54 (53)		
	B	Y	279.23	± 32.25 (207)	-0.57 (262)	0.57
		N	281.48	± 38.94 (141)		
Fantasy	F	Y	286.43	± 28.50 (49)	0.04 (99)	0.97
		N	286.23	± 35.58 (155)		
	M	Y	268.43	± 32.18 (54)	-0.83 (123)	0.41
		N	273.25	± 36.54 (90)		
	B	Y	276.99	± 31.65 (103)	-1.15 (219)	0.25

		N	281.46	± 36.41 (245)		
Customization	F	Y	282.99	± 29.19 (58)	-0.95 (127)	0.34
		N	287.58	± 35.67 (146)		
	M	Y	262.53	± 28.36 (55)	-2.61 (136)	0.01
		N	276.95	± 37.54 (89)		
	B	Y	273.03	± 30.44 (113)	-2.82 (262)	0.01
		N	283.55	± 36.68 (235)		
Targeting Time (ms)						
Social Interaction	F	Y	-138.64	± 100.01 (58)	2.24 (106)	2.74E-02
		N	-173.55	± 98.85 (137)		
	M	Y	-66.29	± 107.56 (74)	3.17 (136)	1.88E-03
		N	-124.07	± 107.69 (66)		
	B	Y	-98.08	± 109.99 (132)	4.93 (269)	1.44E-06
		N	-157.46	± 104.16 (203)		
Stress Relief	F	Y	-146.53	± 96.78 (125)	3.14 (139)	2.07E-03
		N	-192.88	± 100.06 (70)		
	M	Y	-96.78	± 118.43 (101)	-0.63 (90)	5.33E-01
		N	-85.11	± 90.11 (39)		
	B	Y	-124.30	± 109.59 (226)	2.35 (214)	1.95E-02
		N	-154.32	± 109.30 (109)		
Skill Development	F	Y	-167.72	± 109.78 (31)	-0.26 (40)	7.99E-01
		N	-162.31	± 98.65 (164)		
	M	Y	- 49.10	± 104.61 (47)	3.53 (95)	6.34E-04
		N	-115.98	± 107.93 (93)		
	B	Y	-96.25	± 121.02 (78)	3.25 (114)	1.52E-03
		N	-145.54	± 104.31 (257)		

Table 2.20 Logistic Regressions of Reaction Time and Targeting Time in relation to Video Game Motivations

#	Estimate	Std. Error	t value	Pr(>|t|)	Significance
Social Interactions					
#(Intercept)	0.683808	0.2148606	3.183	0.00159	**
#rt	-0.0013612	0.0007415	-1.836	0.06726	
#sexM	0.2134669	0.0527412	4.047	6.40E-05	***
Stress Relief					
#(Intercept)	0.829311	0.212962	3.894	0.000118	***
#rt	-0.000688	0.000735	-0.936	0.349889	

#sexM	0.079663	0.052275	1.524	0.128446	
Skill Development					
#(Intercept)	0.5312739	0.188471	2.819	0.005098	**
#rt	-0.0012907	0.0006505	-1.984	0.048007	*
#sexM	0.16631	0.0462635	3.595	0.000372	***
Adrenaline Rush					
#(Intercept)	2.21E-01	2.04E-01	1.083	0.279532	
#rt	-4.95E-07	7.03E-04	-0.001	0.999439	
#sexM	1.82E-01	5.00E-02	3.642	0.000312	***
Escape					
#(Intercept)	0.6452896	0.2230483	2.893	0.00406	**
#rt	-0.0002678	0.0007698	-0.348	0.72815	
#sexM	0.0593445	0.0547511	1.084	0.27917	
Fantasy					
#(Intercept)	0.3490366	0.205559	1.698	0.0904	
#rt	-0.0003802	0.0007094	-0.536	0.5924	
#sexM	0.1291639	0.050458	2.56	0.0109	*
Customization					
#(Intercept)	0.761419	0.2104952	3.617	0.000342	***
#rt	-0.0016666	0.0007265	-2.294	0.022385	*
#sexM	0.0729077	0.0516697	1.411	0.159135	
Targeting Time and Video Game Motivations					
Social Interaction					
#(Intercept)	0.4505742	0.0519942	8.666	< 2.00E-16	***
#targett	0.0009385	0.000244	3.847	0.000144	***
#sexM	0.1657771	0.0544514	3.044	0.002517	**
Stress Relief					
#(Intercept)	0.7190379	0.0519089	13.852	<2e-16	***
#targett	0.0004781	0.0002436	1.963	0.0505	*
#sexM	0.0471078	0.0543621	0.867	0.3868	
Skill Development					

#(Intercept)	0.2456831	0.0458308	5.361	1.56E-07	***
#targett	0.0005314	0.0002151	2.471	0.01398	*
#sexM	0.1397332	0.0479968	2.911	0.00384	**
Adrenaline Rush					
#(Intercept)	0.2814196	0.0496955	5.663	3.23E-08	***
#targett	0.0004047	0.0002332	1.735	0.0836	
#sexM	0.1635749	0.0520441	3.143	0.00182	**
Escape					
#(Intercept)	0.6037999	0.0547046	11.037	<2e-16	***
#targett	0.0002433	0.0002567	0.948	0.344	
#sexM	0.0546692	0.0572899	0.954	0.341	
Fantasy					
#(Intercept)	0.4162246	0.0491185	8.474	7.84E-16	***
#targett	0.0010737	0.0002305	4.658	4.62E-06	***
#sexM	0.0699149	0.0514398	1.359	0.175	
Customization					
#(Intercept)	0.4760261	0.0506196	9.404	< 2.00E-16	***
#targett	0.001126	0.0002375	4.74	3.18E-06	***
#sexM	0.007854	0.053012	0.148	0.882	

* < denotes significance at <0.05
** < denotes significance at < 0.01
*** denotes significance at < 0.001

Chapter 3. I tweet, therefore I am: Social Media Use and Disorders of the Social Brain

3.1. Abstract

For the first time in evolutionary history, the introduction of social media platforms has enabled people to interact in virtual spaces where temporal, spatial, and embodied cues are decoupled from each other. What implications does this have for socio-cognitive phenotypes and disorders? A narrative review was conducted on the relationships between social media use and social brain disorders via searches of Google Scholar and Pubmed using relevant keywords. The main findings center on evidence of increased social media usage in individuals with psychotic spectrum phenotypes and disorders characterized by perturbations in the basic self, particularly narcissism, body dysmorphia, and eating disorders. Current evidence suggests that increased social media usage, via its disembodied and isolative nature, may be associated with the forms and prevalence of psychotic spectrum phenotypes, especially delusionality, by decoupling of inter and intra-corporeal cues integral in shared reality testing, leading to blurring of self-other boundaries.

Key words: Social media; Schizophrenia; Autism; Psychosis; Embodiment; Ipseity

3.2. Introduction

“The other’s gaze decentralizes my world” (Fuchs, 2002)

Since the advent of social media platforms 15-20 years ago, more and more human social interaction have been moving online. Over two billion people are active social media users worldwide, and more than 3.5 billion people have access to a mobile device (Kemp, 2015). In 2020, 94% of Canadian adults report having at least one account on a social media platform (Gruzd and Mai, 2020). Social media is also increasingly integrated into people’s social lives; for example, 97% of teenagers in the United States use the internet daily (Vogels et al., 2022). To date, approximately 80% and 69% of adults in the United States use YouTube and Facebook, respectively (Auxier and Anderson, 2021). 70% of Facebook users report accessing the site daily, and 49% users report using it several times a day (Auxier and Anderson, 2021). Social media sites have also become the predominant medium in which people socially interact. Regular social media users report using Facebook as a “place to interact and socialize”, where they “have more contact with people via social media than face to face” and that “social media gives them a social life” (Whiting and Williams, 2013). Indeed, as the technology advances, more and more face-to-face interactions are replaced by virtual means such as instant messaging, live video streaming, status updates, and virtual social networks with merging newsfeed and friend/follower requests. What are the psychological and psychiatric implications of the novel environments that social media usage creates? How does psychological makeup influence social media use, and how is social media use associated with risks and forms of psychological disorders? Despite the popularity of social media, the relationships of psychological phenotypes with patterns of social media usage remain understudied and little understood.

Virtualization of social interactions has affected human social behaviors in a suite of domains, including but not limited to the construction of identities, the sharing of mental spaces, joint attention, eye contact, social interaction dynamics, relationships, and monitoring of social status (Table 3.1). Almost all virtual social processes can be asynchronous, entirely dissociated from physical embodiment, and free from temporal or geographic constraints. For example, whereas a traditional face-to-face conversation would involve two people in the same room talking, interpreting, and synchronizing to each other’s body language, pace of speech, and eye contact, a virtual “conversation”

can now be enacted with asynchronous exchanges of text messages with anybody in the world, replete with memes and emojis to establish a virtual shared mental space and facial expressions in lieu of physical cues. This disembodiment profoundly alters the nature of the social information that can be, and is, transmitted or exchanged.

Table 3.1 Comparisons between Real-life vs. Virtual Social Interactions

DOMAINS	REAL LIFE	VIRTUAL
Identity	- continuous via iterated physical exchanges with other people - shared (ex: doctor-patient, teacher-student, actor-audience) - shared with other people by doing activities together - identity co-created by shared narratives (ex: working on the same projects, sharing culture values or traditions)	- discontinuous; can be entirely self-constructed by uploading videos, images, or other content online (ex: catfishing). Can be temporally disconnected with changes in online accounts - can be "shared" virtually with likes, tags, comments or entirely self-curated (ex: impression management) - narratives can be entirely self-generated via the use of videos, photos, or text (ex: creating a fake persona online by using photoshopped pictures or deepfake videos
Shared mental space	- synchronized in tandem with physical actions (ex: body language, eye contact, vocalization) - usually instantiated in physical embodiment (ex: nodding in agreement, dancing together, participating in shared religious rituals) in the same temporal and geographical spaces	- completely disembodied, temporally and geographically asynchronous (ex: retweets, hashtags, Reddit upvotes, Twitter mobs) - can be entirely unidirectional and/or done with an imaginary audience (ex: starting a hashtag on Twitter to make it trend, Zoom Yoga sessions)
Joint Attention	- usually established by physical actions such as shared eye contact, pointing	- simulated or "imagined" into existence (ex: posting a Tweet to an imagined virtual audience that may or may not exist)

Eye contact	- shared by physically aligning pupil direction	- can be entirely illusory (ex: curating Linked In image based on what an imagined employer wants to see) - performative to an imagined audience, usually unidirectional (ex: making a TikTok video for a virtual audience)
Social Interaction Dynamics	- Immediate social feedback based on the other person's body language, verbal response, or some physical cue	- Can be asynchronous, and thus largely rely on the users' imagined or anticipation of what the other social media user is thinking/feeling (ex: Read Receipt Anxiety Syndrome)
Relationships	- largely reciprocal, validated based on iterated physical social interactions	- can be entirely unidirectional and without continuity (ex: following Twitter account anonymously) - can be entirely illusory (ex: Facebook "friending" strangers)
Social Status Monitoring	- "Keeping up with the Joneses" - done by comparing self with family, neighbours, colleagues, people in real life	- "Fear of Missing Out" - done by comparing self with people on newsfeed online

In virtual domains, most social processes also become discontinuous. Thus, unlike in a typical physical social interaction, where a person constructs and maintains their identity based on iterated interactions in shared temporal and physical situations (e.g., work, school, family, and friend networks), digital identities can be self-generated through selective curation of videos, pictures, and timelines, adapted to any online situation, and easily discarded and reinvented with the adoption of new digital accounts. The increasing popularity of following peoples' social accounts also generates an evolutionarily novel situation where anyone, anywhere can make "social contact" and share in each other's social lives by "participating" in one another's social media feeds without ever having met face to face. The rise in social media platforms has thus not only changed how people socially interact in real life (e.g., "lurking" in someone's

timelines instead of talking to them to make contact), but it has also fundamentally altered the human social landscape by dissociating, disembodying, and, as discussed below, amplifying social processes in evolutionarily unprecedented ways.

Perhaps most importantly, virtual social success appears to usually engender high abilities in mentalistic cognition – the capacities involved in inferring, simulating, and anticipating the mental and social needs and reactions of others. Broadly speaking, mentalistic cognition refers to a large set of socio-cognitive abilities including eye-contact, joint attention, theory-of-mind, social imagination, narrative-production, and verbal intelligence – all of which are integral for initiating and facilitating successful social interactions (Crespi and Badcock, 2008). However, unlike in real life face-to-face interactions where one would be able to receive immediate social feedback via physical cues such as body language and facial expressions, the anonymized and atomized nature of online social media interactions means that one is constantly updating and adjusting one's thoughts and activities based on an imagined virtual audience, which, for success, requires high levels of social imagination.

For example, to make a successful TikTok video, a person needs to know, *a priori*, what topics are engaging, and how to convey them to an invisible audience whose feedback will not be available until after the video is posted. Since the audience is not physically present, content creators must be able to anticipate the location and direction of the virtual eyes (i.e., illusory eye contact), focus on the point of virtual joint attention (i.e., illusory joint attention, illusory intentionality), and position themselves and perform in front of the camera in such a way that the imaginary audience feels personally engaged with the individual. Thus, to be socially successful online, one needs to be exceptionally adept in imagining, adapting to, and anticipating the attentional and affective preferences of an imagined virtual audience – all abilities that cluster with high mentalistic skills.

Given that most human mentalistic functions have evolved in face-to-face interactions, what are the expected social-psychological implications of such wide adoption of virtual social technology? In this article we describe and evaluate the hypothesis that social media exaggerates and enhances mentalistic functions, that are over-developed, in the extreme, in so-called psychotic spectrum disorders (i.e., schizophrenia, bipolar disorder,

borderline personality disorder) and under-developed on the autism spectrum. This hypothesis is based on Crespi and Badcock's (2008) model of social brain variation and disorders, which posits that social cognition presents along a continuum, with normality at the centre, and grading towards increased mentalism in one direction, and decreased mentalism in the other.

In contrast to mentalistic traits, autism-spectrum traits are characterized by reduced expression of mentalistic cognition, such as decreased eye contact, decreased joint attention, and decreased social interests, plus enhanced mechanistic traits such as enhanced visuo-spatial skills, interest in objects and mechanical systems (i.e., train tables or spinning wheels on a truck), fixation on special interest topics, stereotyped behaviors, proclivity toward solitary activities or occupations, and literal language interpretation (Crespi and Badcock, 2008). All these traits are associated in some manner with processing regularities in physical systems, which operate via algorithmic rules where input and output can be systematically predicted via pattern recognition (Baron-Cohen et al., 2009, 2011). Given this set of findings, higher levels of autistic traits should be associated with lower rates of social media usage, but high rates of internet usage related to systems and technology. When individuals with autism or high in autism-related traits use social media, the pattern of social media usage should thus be more mechanistic and less mentalistic – that is, individuals with higher levels of autism-related traits should be more likely to use social media platforms to share topics of their special interests, which are more factually-based than socially-driven, and use social media as a way to avoid or substitute for, rather than extend, real-life social contact.

In contrast to autistic symptoms and traits, positive symptoms of psychotic conditions, such as schizophrenia and schizotypy, are characterized by hyper-developments in social cognitive phenotypes, such as feelings of surveillance (i.e., excessive or illusory eye contact), paranoia (i.e., excessive or illusory joint attention), conspiratorial thinking (i.e., excessive or illusory theory-of-mind or social narratives), delusions involving social threats (i.e., delusions of persecution), and unusual perceptions (i.e., bodily hallucinations/delusions) (Crespi and Badcock, 2008). As elaborated above, mentalistic abilities appear to be required for social media success, as high levels of theory-of-mind are necessary for cultivating an online persona that is engaging and efficacious. 'Healthy' positive schizotypal traits, particularly those that enhance as well as extend mentalistic trait expression, should thus be associated with greater social media usage.

Higher social media usage may also, however, be associated with psychotic traits that are facilitated and enabled by the nature of virtual social environments, as illustrated in Table 1.

Based on these considerations, the following a set of predictions can be derived:

(1) The different domains and traits of mentalistic cognition will manifest in particular, relevant aspects of social media use, in non-clinical, and grading into clinical, populations;

(2) Higher levels of social media usage should be associated with increased prevalence of psychotic spectrum traits and disorders; and

(3) Higher levels of autistic traits should be associated with lower social media usage, and internet usage that is geared towards less-mentalistic cognition.

In this paper, these hypotheses were evaluated by adopting both trait-based and disorder-based approaches in a narrative literature review. In the trait-based analysis, we first reviewed the connections between specific psychological phenomenon and social media use, in the context of mentalistic cognition. We do not provide in-depth discussion or anxiety of depression and social media, which have been reviewed extensively elsewhere. In the disorder-based analysis, we analyzed relationships between patterns of social media usage among individuals exhibiting autism spectrum and psychotic spectrum conditions, with particular emphasis on disorders involving positive schizotypal or psychotic traits. We focus in particular on why some psychiatric disorders involve especially pronounced use of social media, while others do not.

3.3. Methods

A narrative review was conducted by exhaustively searching the following keywords in various combinations: “social media”, “Facebook”, “Instagram”, “Twitter” AND “schizotypy”, "schizotypal", “schizophrenia”, “psychosis”, “paranoia”, "personality disorder”, “bipolar disorder”, “narcissistic personality disorder”, “narcissism”, “narcissistic traits”, “body dysmorphic disorder”, “body dysmorphia”, "autism", “autistic traits”, "eating disorder", or “anorexia” in Google Scholar and PubMed. The key inclusion criterion for the disorder-based part of the review was data on patterns and rates of social media

(and associated internet) usage among individuals with psychiatric conditions on the psychotic or autism spectrum. Only papers published in English were selected, and all relevant papers were subjected to Google Scholar searches to find more recent papers that cited them, that also fit the inclusion criterion.

3.4. Results

Patterns of Social Media Usage in relation to Different Mentalistic Domains

Social media as considered here is not a homogenous construct but a conglomeration of functionalities that emphasizes different social functions, depending on the nature of the site in question. For example, although Reddit and Instagram are both considered as "social media", the former is more solitary and text-based, and involves asynchronous discussions dedicated to special interest subforums (subreddits) versus the image-driven Instagram, which is more geared toward curation of a self-narrative via videos, "stories", and images with filters and other imaging-editing tools. Thus, we have divided social media usage patterns in terms of their correspondence to real-life socio-cognitive traits, and potential psychiatric disorders and traits that may be associated with usage, with particular attention to how different social media sites may augment different mentalistic functions.

We thus consider the following domains: (1) social monitoring and paranoia, (2) sexual relationships and erotomania, (3) reality perception, reality distortion and psychosis, and (4) dissociation and depersonalization. We also consider these domains, and the disorders associated with them, in the contexts of self-perception and self-embodiment, and self or body image. Each socio-cognitive trait and its corresponding virtual equivalent, as well as relevant pathologies, is discussed in detail below (Table 3.2).

Table 3.2 How social cognitive traits relate to social media use and potential pathologies in individuals with psychotic traits

Social Cognitive Trait	Virtual Equivalent	Potential pathology in individuals predisposed to psychotic traits
- social monitoring: eye contact, joint attention	- "viewer" or "currently watching" counts on social media sites	- paranoia/conspiratorial thinking (illusory eye contact/joint attention) - feelings of surveillance

	- "read receipts" on instant messaging apps - notifications that someone has viewed a profile	
- interpersonal relationships (friends/acquaintance/extend-ed group members)	- Facebook "friends", Twitter followers, Instagram followers	- illusory fantasy relationships (e.g. erotomania, persecution, conspiratorial thinking)
- self-referential thinking	- retweets, "likes" on Facebook posts - "smart" algorithms on social media sites designed to show curated content consistent with users' previous browsing history. Predictive analytics are also used to generate content that would be consistent with the users' interests	- magical thinking, ideas of reference (delusions of reference), erotomania, delusions of persecution and conspiracies, thought-broadcasting
- social imagination, narrative production	- internet forums with shared interests - virtual networks that are self-reinforcing based on shared ideas, beliefs, or politics (i.e., echo chambers)	- folie à deux (or folie à million) - social delusions (conspiratorial delusion, persecutory delusions, erotomania…etc.)
- Self perception/self-embodiment based on iterated social exchanges and feedback and sensory stimulation that include in-person tactile and other non-verbal cues	- virtual avatars in place of physical bodies - online personas in place of physical identities - selfies, filters, curated self-based images on Instagram and other image-sharing sites - co-creation of digital identifies via Instagram "stories", likes, comments, and tags	- disorders characterized by perturbations in self-perception or somatic delusions (ex: body dysmorphic disorder, anorexia) - disorders of disembodiment (derealization, depersonalization) - excessive extended self (e.g., narcissism)

Social monitoring and paranoia

Before the advent of technology, eye contact was only possible via face-to-face interactions, as individual only interacted within shared embodied and temporal spaces.

Social media has erased both temporal and geographical boundaries for social monitoring via constant real-time updates of peoples' social lives via virtual timelines or newsfeeds. Now, for the first time in human evolutionarily history, the medium for social surveillance is global, constant, and ubiquitous with the adoption of constant status updates, co-sharing of timelines and Twitter threads, and progressive merging of one's online social life with the real (physical) one.

Several lines of evidence suggest that social media may exacerbate feeling of social surveillance via its constant status updates and unpredictability of feedback. For example, young adults have reported curating their social media profiles and privacy settings according to the needs of an imagined audience ("you never really know who's looking") (Duffy and Chan, 2019). One study that involved interviewing young adults on their social media use revealed that women frequently reported feeling being watched and judged on social media (e.g., feelings of being "stared at"), as well as implicit expectations that their online content may be screen-saved and criticized (Gill, 2022). Furthermore, public self-consciousness (i.e., the outward displays of self as a social object) has been shown to be positively associated with a higher frequency of posting photos, replying to comments on photos, and resharing photos on social media, in a sample of South Korean university students (Shim et al., 2008). Emotional venting and viewing profiles of users who were not "friends" on social media, have also been associated with subsequent increases in paranoia (Berry et al., 2018).

'Read receipts', electronic notifications that a sent message has been opened and "read" by the recipient, have been widely adopted across social media platforms. A qualitative study found that university students often worry about what the other person is thinking when their messages are read but not responded to ("I think it makes people insecure… You have time to overthink about that situation… until the person responds") (Lynden and Rasmussen, 2017). One study presented participants with a sample text message conversation and asked them why a message was left on "read" with no response; most participants inferred that the non-response was intentional, and that a non-response constituted a rejection even when no explicit rejection was made (Earle, 2018). Taken together, these lines of evidence suggest that the asynchronous and disembodied nature of social media has created a ubiquitous sense of remote surveillance, that may exacerbate feelings of social anxiety and paranoia, via excessive perceived virtual surveillance and social ambiguity.

Sexual relationships and erotomania

Before the advent of online social media, human courtship and sexual relationships were initiated and built via face-to-face physical interactions. The virtualization of social media is expected to alter the nature of such relationships in several important ways, potentially leading to enhanced risks for several forms of pathologies.

First, as more relationships are virtualized, the incidence of erotomaniac delusions is expected to increase as initiations of romantic or sexual encounters become largely one-sided and based on illusory interest. Once referred as “psychose passionelle” (De Clerambault, 1942), erotomania is a delusion wherein the individual, usually a young woman, believes that another person, usually of higher social status or unattainable in some other way, is in love with them despite an absence of evidence. Erotomania has thus been considered as an "excessive theory-of-mind” delusion where the individual becomes infatuated with impossible love objects (Charlton and McClelland, 1999), with mis- or over-attributing mental states of reciprocated love to others. Erotomania also commonly co-occurs with other psychotic disorders, including persecutory delusional disorder, schizophrenia (Jordan et al., 2006), paranoid psychosis (Marckmann et al., 2005), bipolar disorder, and schizoaffective disorder (Kasantikul, 1998).

Second, social media has removed or reduced the physical and temporal barriers on mate seeking, which means that previously unattainable individuals (e.g., Hollywood stars) may appear accessible as prospective mates, since anyone can initiate contact via virtual means. The rise of ‘influencer culture’ on social media may also encourage more intimate experiences of ‘parasocial’ relationships; that is, illusory and one-way relationships where the viewer or social media user perceives the social media personality as a “friend” despite a lack of real-life interactions. In line with this view, exposure to, and interacting with, social media personas increase the strength of perceived parasocial attachment (Bond, 2016; Baek et al., 2013; Frederick et al., 2012; Stever and Lawson, 2013) and attraction (Kurtin et al., 2018). These data suggest that even mere exposure to virtual personas can increase feelings of emotional attachment in neurotypical and healthy individuals, with increased exposure potentially leading to elevated risk of triggering forms of erotomania in vulnerable individuals.

Third, the typical patient with erotomania has been noted to be timid, sensitive, and socially isolated, experience difficulties with interpersonal attachments, and with tendencies towards ideas of reference (Retterstøl and Opjordsmoen, 1991). Erotomania is also a female-biased delusional disorder, with a female to male ratio of about 3:1 (Kelly, 2005). Accordingly, five out of seven published case studies of social media-related erotomania show that the patient was female (Sayar and Senkal, 2014; Kuo and Hwu, 2007; Prasad et al., 2020). Moreover, the patient is typically socially isolated, using social media as the primary or sole source of social interactions (Sayar and Senkal, 2014; Krishna et al., 2013). Consistent across studies, patients also experience delusions of reference and perceived special hidden meanings in their love objects' social media updates as "evidence" of their illusory love relationships (Sayar and Senkal, 2014; Faden et al., 2017; Krishna et al., 2013). Under a model of excessive mentalistic virtualization of socio-sexual interactions, high levels of social media usage may facilitate erotomaniac delusions in individuals who are socially isolated, exhibit impaired reality testing, lack real-life intimate relationships, and are prone to positive schizotypal traits such as excessive ideas of reference and magical thinking – all characteristics of the typical erotomania patient as described in the case studies in Table 3.3.

Table 3.3 Case studies of social media usage associated with erotomaniac delusions

Reference	Case	Age	Sex	Psychiatric history	Case reports
Sayar and Senkal, 2014	1	40	F	Depression	Patient lived alone and was unemployed when she was first brought to medical attention. Patient fell in love with someone she "met" on FB and persisted in sending the "friend" symbolic messages of their love despite the person having cut off all contact.
	2	35	F	None reported	Patient was single, lived alone, and spent majority of her free time on social media. Patient fell in love with a man she "met" on FB and was devastated when he rejected her advances. However, the patient remained fixated about their "love" and consistently spoke of the man being "inside of her".

	3	20	F	Depression with psychotic features	Patient reportedly spent entire days surfing on Facebook. Patient reportedly fell in love with a man on FB fell in a psychotic depression when he rejected her in person.
Faden et al., 2017	1	24	M	None reported	Male college student developed the erotomaniac delusion on a female classmate and started stalking her on Twitter and in-person. Patient was also convinced that multiple other women were in love with him despite lack of evidence.
Kuo and Hwu, 2007	1	18	F	None reported	The female patient fell in love with a man that she has only "met" online. Patient had communicated with the man over email for three years. Patient became suicidally depressed after receiving a message from another online friend that the "boyfriend" and his family had killed themselves. Patient was convinced that she was to blame for the suicides and became suidically depressed.
Krishna et al., 2013	1	21	M	Had seen a counselor for "depression" in high school. Patient's mother and half-sister had depression.	Family described the patient as introverted and isolative. Patient led a socially isolated life where he worked a job with minimal social interactions and only interacted with "friends" via FB. Patient developed an erotomaniac delusion on a female classmate who had accepted his online FB "friend" request. Although they never communicated offline, the patient started over-identifying with the female classmate and interpreted her social media updates as evidence of her "love" for him.

Prasad et al., 2020	1	21	F	None	Patient developed an erotomaniac delusion that she was in love with a boy from her 12th grade cohort. Patient would message men with similar sounding names on FB and send inappropriate messages to them. Patient is noted to be constantly messaging men on FB, even during the ward stay when she was hospitalized.

Reality perception, reality distortion and psychosis

Reality distortion in psychosis includes magical thinking, ideas of reference (delusions of reference), thought broadcasting, and conspiratorial and persecutorial delusions. Increased immersion in virtual social media environments may be conducive to psychosis by altering reality perception in several ways. First, most social media platforms employ various forms of hidden website trackers that follow, monitor, and analyze users' behaviors across a variety of websites to generate individualized ads and newsfeed to increase user engagement. The automatic curation of online content tailored to each users' activity may promote the development of ideas of reference, as content is automatically and spontaneously updated "just-so" to each users' previous activity (Kalbitzer et al., 2014). Furthermore, the sense of disembodiment, blurring of self-other and private-public boundaries in online spaces, and lack of physical non-verbal cues may also increase feelings of mistrust, even paranoia, as online communications tend to be more ambiguous and thus open to misinterpretation (Nitzan et al., 2011).

The increasing deployment of smart algorithms in social media platforms may also increase levels of hyper-mentalizing. For example, Twitter algorithms track users' top-engaged accounts and rank them, accordingly, curating the news feed in such a way that the users' most engaged account is shown first, which may heighten feelings of surveillance and delusions of thought-broadcasting as the website just "knows" what the user is most interested in. Indeed, paranoia is negatively associated with attitude toward purchasing online, a finding that may be mediated by general distrust of advertisers' use of subliminal messages (Zimaitis et al., 2020). Over time, the constant exposure to the

individualized content may increase feelings of suspiciousness or paranoia that "someone" is watching them and may serve to reinforce or exacerbate an individual's underlying psychotic traits. Numerous case studies of social media or internet-related psychosis have been reported in the literature, that may derive in part from these considerations (Table 3.4).

Table 3.4 Reports of psychosis associated with social media or internet usage, or specific mentalistic aspects of social media systems

Reference	Case	Age	Sex	Psychiatric history	Case reports
Kalbitzer et al., 2014	1	31	F	None reported	Patient was using Twitter excessively approximately one year prior to psychiatric admission, neglecting her personal relationships for tweeting several hours a day. Patient suffered from paranoid delusions and perceived special hidden meanings in her retweets and felt compelled to carry out special "tasks" as a result (ex: picking up a piece of tissue when she heard a car honk)
Lerner et al., 2006	Case 1 (Ms. B)	24	F	None reported	Patient lived alone without family or social support. Patient was reported to be fearful, shy, and rarely went out with friends. Patient developed the psychotic belief that she was being "irradiated" by the internet and that anyone who had access to a computer was able to connect with her, monitor her, and control her thoughts and actions.
	Case 1 (Mr. C)	28	M	None reported	Patient was a single man and appeared 'cold and aloof'. As an adolescent the patient spent hours in his room programming and rarely went out with his classmates. Patient wore a saucepan to protect himself from the Internet and believed that there was a "world energy" from the Internet that affected his mind and body. Patient also believed that there was a minicomputer in his head.

Bell et al., 2005	Case 1	31	F	Previous diagnosis of bipolar disorder	Patient believed that she had uncovered secret information about the Al-Qaeda terrorist online and, consequently, believed that her communications were tapped. Patient believed that she was bugged with secret microphones and camera.
	Case 2	42	M	None, but had consulted GP previously for low mood and suspiciousness	Patient believed that websites of international companies were being used by a "secret organization", which was out to persecute him. Patient believed that indecent images of his wife and daughter were being distributed online by the secret organization.
	Case 3	36	F	Bipolar disorder	Patient believed house was bugged by cameras that were monitoring and broadcasting her activity online
	Case 4	19	M	Schizophrenia, substance and alcohol abuse	Patient believed that he was followed by "thirty to forty people", who were disgusted with his past misdeeds and wanted him back in the hospital (patient was previously hospitalized). Also believed that the internet was being used to broadcast his past offence (a practical joke he had done in the past)
Schmid-Siegel et al., 2004	Case 1	36	F	Paranoid schizophrenia	Patient believed that her activity was being broadcasted online. Also believed that chip was implanted in her brain and used to broadcast everything she was seeing online
Margolese et al., 2002	Case 1	26	M	Schizophrenia	Patient believed that people were following his activities online, and that several websites were dedicated to him based on similarities between the websites' names and his first name. Patient also experienced paranoid ideas of reference from TV and radio.
Kobayashi et al., 2001	Case 1	57	F	Schizoaffective disorder	Patient heard commanding hallucinations through the internet.
Podoll et al., 2000	Case 1	32	M	None reported	Patient believed that he was receiving messages over the internet, which threatened to expose his use of internet pornography.

	Case 2	19	M	None reported	Patient believed that Bill Gates was destroying his files, as well as stalking him online. Also believed that his personal files were duplicating themselves and broadcasted online.
Catalano et al., 1999	Case 1	40	M	None reported	Patient believed that friend was posting erotic videos of him on the internet. Patient also believed that he was being bugged by a friend who worked in the CIA. Also believed that his body was connected and controlled by the internet via weblinks.
	Case 2	41	M	None reported	Patient identified as a witch and believed that he could surf the internet with his mind. Also believed that he was receiving "magnetism" from the internet.
Tan et al., 1997	Case 1	27	M	Body dysmorphic disorder	Patient believed that the internet was controlling his life. Believed that neighbour was broadcasting his life online. Proposed to a woman that he had connected online and then believed that they were plotting to kill him.
Duggal et al., 2002	Case 1	31	M	Paranoid schizophrenia	Patient believed that he was being persecuted by his sister-in-law, who was controlling and monitoring his thoughts through the internet
Compton, 2003	Case 1	53	F	"Previous hospitalization" not specified	Patient believed that the internet was controlling her movements and home appliances.
	Case 2	21	F	None reported	Patient believed that microchips were implanted in her body/clothes to track her behavior. Also believed that her life was being broadcasted online
	Case 3	64	F	None reported	Patient believed that the "www" people (referring to the world wide web) were following and monitoring her whereabouts by tapping her apartments.

Nitzan et al., 2011	Case 1	45	F	None reported	Patient reported that she had turned to social media sites to relieve loneliness after her client (patient was a caregiver for an old man) has died. Patient reported that her online interactions felt disorienting ("You don't see a human being in front of you… I didn't know who I was communicating with and who was communicating with me…) and experienced ideas of reference using social media and developed paranoia that other online users were after her
	Case 2	30	F	Previous history of anxiety	Patient started communicating with a man via Facebook and developed ideas of reference from his status updates, interpreting special meaning hidden in the clips/colours/words that the man posted. Patient reported that communicating with the man via FB took up most of her day. Over time, patient started developing paranoid delusions about the man as she could no longer trust that their messages were private, and that the man and his family might harm her.
	Case 3	30	F	None reported	Patient developed intimate feelings for a man that she has met online and started experiencing tactile hallucinations as their "relationship" progressed ("I actually felt his hand touching me… on my stomach")

Several common themes link these cases of internet or social media-related psychosis. First, several case studies have observed that patients were typically socially isolated and spent time online in lieu of real-life relationships (Kalbitzer et al., 2014; Lerner et al., 2006; Nitzan et al., 2011). Second, feelings of surveillance (i.e., being monitored, tracked, followed) were reported in the majority of case studies (Bell et al., 2005; Schmid-Siegel et al., 2004; Margolese et al., 2002; Podoll et al., 2000; Catalano et al., 1999; Tan et al., 1997; Duggal et al., 2002; Compton, 2003). For example, one case study (of Patient 'A') observed that the patient reported people were following his activities online, and that a popular search engine was tracking his activities, as the

name of the search engine shared the first two letters of his first time (“Al in” “Altavista.com”) (Margolese et al., 2002). Although the patient had cited a bizarre and implausible reason for being tracked online (i.e., name similarity) (Margolese et al., 2002), modern search engines do monitor and curate results based on user activity, which may reinforce ideas of reference in high-risk individuals already predisposed to psychotic traits. Thus, the self-reinforcing nature of internet searches and smart algorithms may strengthen budding delusional beliefs. For example, patient W.L., who had a history of bipolar disorder, was already experiencing intrusive thoughts and feelings of suspiciousness when she started searching for the term “phenylalanine” online. When W.L. came across a webpage on an Aramaic system for divining special meaning from numbers, she interpreted it as secret information about the “Al-Qaeda” network and became paranoid that she was being monitored and tracked (Bell et al., 2005). Likewise, patient K.D., who had previously consulted a physician for feelings of suspiciousness, developed the persecutory delusion that a secret organization was after him and his family, citing that the secret organization was behind hidden sections of several international companies’ websites (Bell et al., 2005). Given that most websites do contain hidden sections that are not accessible to the general public, the uncertainty between private-public boundaries in online spaces may increase feelings of social surveillance to pathological levels in individuals who are already prone to prone to paranoid ideation, as illustrated in the examples above.

Case reports have also noted that increased exposure to social media may lead to ideas of reference in individuals predisposed to psychosis (Nitzan et al., 2011). In all three case studies reported by Nitzan et al. (2011), the patient started experiencing psychotic symptoms, particularly delusions of reference, as they increased their social media usage to supplement the lack of interpersonal intimacy in their lives. In two of the three case reports, the patients started perceiving special hidden meanings in their social media newsfeeds and “friends” online messages with increasing social media use (Nitzan et al., 2011). Given that most social media newsfeeds show users content that they are most “interested” in, the self-reinforcing cycle of smart algorithms may provide positive feedback that strengthens delusions of reference in users predisposed to psychotic-affective traits.

Dissociation and depersonalization

Dissociation, the experience of disconnections between sense of self, thoughts, memories, and emotions and detachment from the bodily self, personal agency, and objective reality, represents an imagination-based psychological experience that is both a typical experience in everyday life (e.g., in daydreaming), and, in excessive form, a feature of positive symptoms of psychosis (Longden et al., 2020). Use of social media is an intrinsically dissociative experience, given that the individual is generally mentally detached from their current physical and bodily surroundings as they focus on the online content at hand. Indeed, several studies have linked dissociation with social media use or other internet-based activities. For example, problematic social media usage and excessive Internet use have been associated with higher levels of dissociative experiences (Kircaburun et al., 2020; Canan et al., 2012). Exposure to virtual reality environments has been found to increase subsequent feelings of dissociation, as well as diminish feelings of real-life presence in objective reality, in a sample of healthy college students (Aardema et al., 2010). Moreover, increased participation in other virtual activities such as video gaming and virtual meetings has also been positively associated with depersonalization experiences (Ciaunica et al., 2022). Given that social media usage induces dissociative symptoms in healthy individuals, excessive social media usage may be associated with more pronounced symptoms of dissociation, involving aspects of psychosis, among individuals predisposed to psychotic traits and socially isolated from the ‘real-life’ social world.

DISORDER LEVEL OF SOCIAL MEDIA USAGE AND SOCIAL BRAIN DISORDERS

Psychotic Spectrum and General Social Media Usage

Psychosis involves reality distortions: the loss of abilities to differentiate what is real and what is not. Given that the psychotic spectrum encapsulates a wide range of conditions, we summarize each condition’s relationship to this spectrum, and to social media usage, in detail below.

Schizotypy and schizophrenia

Currently available studies have yielded mixed findings on whether positive schizotypal traits are associated with greater social media usage (Table 3.5). For example, Mittal et

al. (2007) found that adolescents diagnosed with Schizotypal Personality Disorder spent more time in online chat rooms compared to controls; severity of SPD symptoms were also positively correlated with cooperative online gaming, internet chat room, and email usage. Similarly, in a sample of young adult with psychotic-like experiences, problematic internet usage and reality substitution (the extent to which the individual perceives the online environment as another "reality" and immerses themselves in it) showed longitudinal decline in the group whose psychotic-like experiences improved or remained steady; in contrast, levels of problematic internet usage and reality substitution were constant in the group whose psychotic-like experiences increased (Mittal et al., 2013). Likewise, Massaro et al. (2022) reported that schizotypy total scores predicted internet addiction behavior and frequency of Facebook use in a sample of undergraduate university students. In addition, Hogg (2009) found that college students who spent 'excessive' time instant messaging endorsed higher levels of suspiciousness, fearfulness, and dissociation from reality – all of which are common features of positive schizotypy.

Table 3.5 Relationships between social media usage and schizotypal traits

References	Methods	Main Findings
Mittal et al., 2007	Self-reports of daily Internet use in adolescents with SPD (N = 19), a control group with other personality disorder (N = 22) and a healthy control group (N = 28)	- participants with SPD reported significantly less real-life social interactions and more online social interactions (ex: online gaming, online chat rooms) than controls SPD symptom severity positively correlated with chat room participation, cooperative internet gaming and email use
Mittal et al., 2013	- 170 young adults (mean age = 19.1) were followed for two months. They were categorized into two groups: (1) steady/improved course of psychotic-like experiences (PLE) and (2) those showing increases in psychotic-like experiences. Psychotic-like experiences were measured with the Prodromal Questionnaire-Brief.	- although both groups reported similar levels of internet addiction and reality substitute at baseline, the PLE improved/constant group showed longitudinal declines in both domains whereas PLE-Increase group's reported level remained constant

	- PLE improved/constant group (127 adults, 81 males, 46 females, mean age = 18.9). PLE increase group (43 adults, 26 males, 17 females, mean age = 19.7) - Internet addiction and a factor "reality substitute" (i.e., the extent to which the individual perceives the internet as another reality and over depend on it for relieving real life problems) were examined within and between the two groups	- psychotic-like experiences moderately correlated with problematic internet usage; magnitude of association with Reality Substitute for the PLE-Increase group grew significantly over time
Massaro et al., 2022	- 270 undergraduate students (age range = 18-30, 50% female and 50% male) completed the following questionnaires: demographics and health questionnaire, Facebook Use Scales, Internet Addiction Test, Schizotypal Personality Questionnaire Brief-Revised, Generalized Anxiety Disorder 7-item Scale, Personal Health Questionnaire Depression Scale (PHQ-8)	- Schizotypy total scores predicted internet addiction behavior and frequency of Facebook use - Disorganized schizotypy was the strongest predicator of internet addiction symptoms
Hogg, 2009	- 159 African-American college students (126 females, 33 males, mean age = 21.6) completed the Minnesota Multiphasic Personality Inventory, the Saba-Penn Demographic Survey, the Cross Cultural Research Team Communications Questionnaire	Participants who spent "excessive" time instant messaging were more likely to endorse hypersensitivity, suspiciousness, odd behaviors, unusual perceptions, and feeling of disconnection from reality,

Notably, Hogg (2009) also found that spending 11-15 hours a week on instant messaging and social media was associated with the highest level of psychological well-being. Risk to well-being increased when instant messaging dropped below or increased beyond this level. Furthermore, psychopathological symptoms (e.g., suspiciousness, rigidness in thought, peculiar perceptions, and dissociation from reality) were most strongly associated with instant messaging when it exceeded 26 hours a week (Hogg, 2009).

These findings suggest that positive schizotypy may be associated with greater social media usage, with the effect moderated by different levels of social media usage. However, given that only one out of three available studies directly tested the relationships between positive schizotypy and social media (i.e., Facebook) usage (Massaro et al., 2022), further studies are needed.

Two studies investigated the relationship of social media usage among individuals with psychotic-like experiences or schizophrenia. One study found that number of hours of social media use per day contributed significantly to the prediction of positive psychotic-like experiences in a sample of non-clinical undergraduate students (Fekih-Romdhane et al., 2021). By contrast, adults diagnosed with psychosis used social media less, compared to the control group (Berry et al., 2018).

Table 3.6 The relationships between social media usage and schizophrenia spectrum disorders

References	Methods	Main Findings
Fekih-Romdhane et al., 2021	The Positive Subscale of Community Assessment of Psychotic Experiences and the Arabic Social Media Addiction Scale (ASMAS) were administered to a total of 1007 college students (64.6% female; mean age = 21.9).	Number of hours of social media use per day contributed significantly to the prediction of positive psychotic-like experiences (bizarre experiences, perceptual abnormalities, persecutory ideation, and magical thinking)
Berry et al., 2018	25 non-clinical controls (11 male, 14 female, mean age = 35.4) and 19 clinical individuals (7 male, 12 female, mean age = 33.7) with a diagnosis of schizophrenia spectrum disorder with psychosis completed self-assessment of social media use, perceived social rank, mood, self-esteem, and paranoia over a 6-day period using the experience sampling method	Participants diagnosed with psychosis used social media less compared to the non-clinical group, and were less likely to use FB than controls The following social media activity predicted increases in paranoia: 1) posting about feeling and emotional venting, 2) viewing profiles of people who were not “friends” on social media, (3) commenting on other peoples’ status updates

Bipolar Disorder

Given that mania episodes in bipolar I disorder are characterized by hyper-mentalistic (e.g., paranoia, feeling of surveillance, delusions of reference) and hyper-social behaviors (e.g., sex promiscuity, gregariousness), social media usage is expected to increase during the manic phase of bipolar I disorder.

Rosen et al. (2013) administered the Millon Multiaxial Clinical Inventory (MCMI-III; Millon et al., 2009) to 1143 adults; this questionnaire measures clinical symptoms of psychological disorders, and technology/social media usage, attitudes about technology usage, and technology-related anxiety. Clinical symptoms of bipolar-mania were associated with more general FB use, increased FB impression management, and more FB friends (Rosen et al., 2013). Compared to controls, outpatient individuals with bipolar disorder were also more likely to use online dating platforms, and to report higher rates of 'regretted' behaviors (e.g., sending videos and messages privately) and transgressive behaviors (i.e., self-reports of friends or family finding their behaviors inappropriate), as well as negative interpersonal consequences in using social media compared to controls (Rydahl et al., 2022).

Matthews et al. (2017) surveyed social media usage in individuals with a bipolar spectrum disorder, finding that 59% of participants reported that their technology use changed with their mood episodes ("If my social media interactions lessen or increase it can be signs of episodes. If I ignore technology and communications with others via text etc., I am more than likely heading to a depressive episode". Given that this study did not employ a control group, however, there is no data available to determine whether patients with bipolar disorder increased or decreased their social media usage in mania or depression compared to euthymic controls.

In contrast to Rosen et al. (2013), Martini et al. (2013) found that patients with bipolar I or bipolar II disorder had fewer close contacts and acquaintances on Facebook, showed less familiarity with social networking sites, less experienced with using the Internet and Internet devices, and have fewer digital devices compared to controls.

Narcissistic Personality Disorder

Narcissistic personality disorder (NPD) is characterized by grandiose self-perception, need for admiration, interpersonally exploitative behaviors, and lack of empathy (American Psychiatric Association, 2013). Narcissistic personality disorder is typically characterized by fantasies of grandeur, or the idea that the self is exaggerated to be unique and superior, although it can also involve forms of psychological vulnerability expressed in social hypersensitivity and defensiveness (e.g., Gabbard, 2022). NPD is comorbid with several other psychotic/affective spectrum conditions, including paranoid personality disorder (Herpertz et al., 1994; Stuart et al., 1998), major depression (Stinson et al., 2008; Ronningstam, 1996), and bipolar disorder (Ronningstam, 1996; Simonsen and Simonsen, 2011; Ronningstam and Weinberg, 2013).

Cardinal characteristics of NPD are exhibitionism, entitlement, and excessive need for admiration (American Psychiatric Association, 2013) – all of which are consistent with the mentalistic trait of social surveillance. Given that narcissism is characterized by excessive need for admiration and self-aggrandizing behaviors, higher narcissistic traits are expected to be associated with greater social media usage, as well as self-promotional behaviors, an expectation that is borne out by the evidence in Supplementary Table 1.

As summarized in Supplementary Table 1, increased narcissistic traits are thus notably associated with greater social media usage (Mehdizadeh, 2010; Panek et al., 2013; Horton et al., 2014; Walters and Horton, 2015; Singh et al., 2018; Kircaburun and Griffiths, 2018; McCain and Campbell, 2018; Fox and Rooney, 2015), although some findings observed no statistically significant relationships between the two (Bergman et al., 2011; Skues et al., 2012; Weiss, 2013), and one study observing that there was no significant associations between narcissism and social media usage (Frederick and Zhang, 2019).

Narcissism also shows evidence of being associated with greater motivation for using social media to project a positive self-image (Bergman et al., 2011), and for other self-promotional purposes (Marshall et al., 2020; Buffardi and Campbell, 2008). Narcissism is thus linked with more status updates (Mehdizadeh, 2010; Panek et al., 2013; Ong et al., 2011; Wang et al., 2012), number of FB friends (Schwartz, 2010; Singh et al., 2018;

Pettijohn et al., 2012; Chen, 2014; Kojouri, 2015; McKinney et al., 2012), increased frequency of selfie-posting (Weiser, 2015; Singh et al., 2018; Andreassen et al., 2017; Giordano et al., 2019; Arpaci et al., 2018; Biolcati and Passini, 2018), number of selfies (Giordano et al., 2019; Fox and Rooney, 2015), liking of selfies (Charoensukmongkol, 2016), greater photo-editing behaviors (Fox and Rooney, 2015), greater frequency of posting, tagging, and commenting on photos (Alloway et al., 2014), and higher self-ratings of their FB profile picture (Ong et al., 2011). Taken together, the findings noted above are consistent with reports that individuals high in narcissism tend to be more motivated to seek out situations of positive self-attention, such as gazing at oneself in the mirror, and increased preference of watching oneself on videotapes rather than watching videotapes of others (Robins and John, 1997).

Researchers have also noted that individuals higher in narcissistic traits may be attracted to social media platforms, as they allow for a large network of loose and impersonal relationships as well as various tools for self-enhancement (Buffardi and Campbell, 2008). Accordingly, scores on the Grandiose-Exhibitionism dimension of narcissism predict self-promoting FB behaviors, FB friends count, and frequency of accepting strangers as FB friends (Carpenter, 2012), as well as placing greater importance on receiving responses online and looking popular on social media (Zell and Moeller, 2017). Grandiose narcissism has also been positively related to time spent on social media, frequency of status updates, number of friends/followers, and frequency of selfies posted on social media (McCain and Campbell, 2018). FB users were more likely to be narcissistic and extraverted than non-FB users (Ryan and Xenos, 2011). As observed previously by Carpenter (2012, p.485), patterns of social media usage in narcissism appears to be an “extensive self-presentation to as large as an audience as possible”, which is consistent with the current data showing that individuals with narcissism tend to use social media for self-promotional purposes (Supplementary Table 1). However, Frederick and Zhang (2019) have observed no significant relationships existed between narcissism and social media usage. Given that social media is increasingly being incorporated into everyday life, general usage may no longer be as useful an indicator for differences in individual personality traits due to increased incorporation of technology in daily tasks, a variable that future research may consider in the design of studies.

Borderline Personality Disorder

Borderline personality disorder (BPD) is characterized by pervasive pattern of instability of interpersonal relationships, mood swings, labile affect, impulsivity, self-harm or suicidal behaviors, chronic feelings of emptiness, dissociative symptoms, and transient stress-related paranoia (American Psychiatric Association, 2013). Borderline personality disorder frequently involves positive psychotic symptoms (Coid et al., 2009; Glaser et al., 2010; Kelleher and DeVylder, 2017). Accordingly, by the hypotheses evaluated here, borderline personality disorder should be associated with increased social media usage.

Higher borderline personality disorder traits have been associated with greater frequency of posting on social media, greater self-reports of regret after posting on social media, greater likelihood of editing or deleting posts after posting, more frequency friending and unfriending behaviors on social media (Ooi et al., 2020). Furthermore, borderline personality traits are associated with increased cyberbullying behaviors in adolescents, particularly malicious social gossip (Stockdale et al., 2015), the production of which requires substantial mentalizing skills (e.g. social network monitoring, reputation tracking) (Dunbar, 2004).

Histrionic Personality Disorder

Histrionic personality disorder is characterized by excessive attention-seeking behavior, suggestibility, theatricality, being uncomfortable in situations when they are not the center of attention, and considering relationships to be more intimate than they really are (American Psychiatric Association, 2013). In a sample of 26 patients with recent-onset bipolar spectrum disorder, histrionic personality disorder was found to be the top co-occurring personality disorder; in comparison, schizotypal personality disorder was the top comorbid personality disorder in a group of patients diagnosed with recent-onset schizophrenia (Pica et al., 1990).

Considering that most social media encourage self-displays (i.e., status updates, selfies), excessive theatricality and attention-seeking behaviors in the histrionic personality disorder should be associated with greater social media usage, as well as greater self-display behaviors such as selfie-posting. Accordingly, histrionic personality traits have been associated with greater social media usage, addictive use of social media, and increased selfie-sharing (Akça et al., 2020). Similarly, histrionic traits

predicted number of selfies posted online, but in men only (Sorokowski et al., 2016). The currently available data thus supports the prediction of higher mentalistic traits (i.e., self-display to a virtual audience) in that histrionic personality disorder is associated with greater social media usage. However, given that there are only two available studies, additional studies are needed.

Body perceptual disorders: body dysmorphic disorder and anorexia

Both Body Dysmorphic Disorder (BDD) and anorexia are characterized by extreme distortions in body self-image. Historically considered as prodromal to, or a variant of, schizophrenia (Zaidens, 1950; Phillips, 1991; Cotterill, 1981; Yamada et al., 1978), BDD is characterized by excessive occupation with a slight or imagined physical flaw; consequently, the individual may engage in compulsive grooming or reassurance-seeking behaviors as to correct or hide the perceived flaw.

In contract to individuals with BDD, individuals with anorexia perceives themselves to be excessively overweight, despite evidence to the contrary, and may restrict feeding and/or compulsively exercise excessively to mitigate the self-perceived weight gain. As in BDD (Walker et al., 2009), individuals with AN also engage in excessive or compulsive body-checking behaviors such as examining their body or body parts in the mirror, checking if their thighs touch, or pinching the stomach to see if it is excessively fat (Reas et al., 2002; Shafran et al., 2004).

Both BDD and anorexia involve several psychotic spectrum traits. For example, BDD is often characterized by ideas or delusions of reference, where they are convinced that other people are mocking or noticing their physical flaws (Phillips et al., 1993, 2005), experiencing such distress that they may become housebound to avoid being seen (Phillips et al., 2005; Phillips and Diaz, 1997). Schizophrenia also shows significant positive genetic correlations with anorexia and other eating disorders (Solmi et al., 2019), indicating a shared genetic based, and BDD exhibits both delusional (psychotic) and somatic presentations, both with high frequencies (Raman, 2013).

Given that both BDD and anorexia are characterized by perturbations in body perception, increased social media usage may promote the expression of BDD and AN, as most social media platforms are image-based and encourage the use of multiple photo-editing tools that can be used to create unrealistic expectations of the statistically

“normal” body proportions, as individuals compare their bodies to curated images seen on social media. In addition, individuals with BDD and anorexia also engage in compulsive and excessive mirror-checking as part of their body perceptual disorders; as such, given that most social media platforms are image-centric and “reflect” back its users visually-based content, BDD, body dysmorphic traits and anorexia should also be positively associated with greater social media usage as virtual extensions of mirror-checking behaviors. As summarized in Table 8, increased social media usage has indeed been associated with increased eating disorder symptoms (Yellowlees et al., 2019; Turner and Lefevre, 2017; Santarossa and Woodruff, 2017; Mabe et al., 2014), greater body dissatisfaction (Howard et al., 2017), weight and appearance dissatisfaction (Murray et al., 2016), preoccupation with body and food intake (Sidani et al., 2016), internalization of the thin ideal, and dieting behavior (Tiggemann and Slater, 2014).

Increased exposure to image-centric social media platforms may also be associated with greater body dissatisfaction and thus eating pathology. For example, Cohen et al. (2017) found that Instagram users tend to score higher on the body surveillance than non-Instagram users, and greater interaction with image-centric content on FB (e.g., updating one’s profile photo and viewing other peoples’ photos) were associated with increased body surveillance. FB users reported significantly lower body satisfaction than non-users (Stronge et al., 2015), and increased emotional connection and integration of FB into one’s life was associated with increased online physical appearance comparison, which in turn has been associated with greater levels of disordered eating (Walker et al., 2015). Furthermore, viewing idealized and edited Instagram images has been associated with greater body dissatisfaction (Tiggemann and Anderberg, 2020). Instagram photo-based activities positively predicted both drive for thinness and body dissatisfaction through the mediating variable of appearance-related comparisons (Hendrickse et al., 2017). The frequency of FB-photo related activities was also positively correlated with internalization of the thin ideal, self-objectification, and drive for thinness, and negatively correlated with weight satisfaction (Meier and Gray, 2014).

Tiggemann and Slater (2017) found that number of FB friends, but not FB usage, prospectively predicted greater drive for thinness in a sample of adolescent girls, suggesting that it may be the excessive virtual body comparison, but not general social media use, that is driving symptoms of eating pathology. In addition, Lonergan et al.

(2020) found that both avoidance of posting selfies and photo manipulation were associated with greater adjusted odds of meeting criteria for clinical/subclinical anorexia (Lonergan et al., 2020). The same study has also found online selfie-posting was unrelated to both eating disorder symptom severity and body dissatisfaction. In contrast, Butkowski et al. (2019) has found that frequency of Instagram use was not associated with greater body dissatisfaction or drive for thinness. Finally, in a recent meta-analysis, Ioannidis et al. (2021) demonstrated that eating disorders, drive for thinness, and dietary restraint were all associated with increased and 'problematic' internet use.

Table 3.7 Relationships between social media usage and BDD

References	Methods	Main Findings
Alsaidan et al., 2020	- cross sectional study conducted during January and February 2020 - 1010 participants completed the Body Dysmorphic Disorder Questionnaire (BDDQ) and social media usage questionnaire online. - 4.2% of the participants met the BDD diagnosis threshold ("BDD status") via scores on the BDDQ	BDD associated with spending more time on Snapchat and Instagram
Senín-Calderón et al., 2020	- 796 participants (mean age = 22.5; 54% women) completed the Dysmorphic Concern Questionnaire, Referential Thinking Scale, Difficulties in Emotion Regulation Scale, Physical Appearance Comparison Scale-Revised, and a questionnaire on Instagram use	Direct effect between Instagram use and dysmorphic concerns was not statistically significant
Griffiths et al., 2018	- 2,733 sexual minority men (mean age = 33.9) completed questionnaires on social media and dating app usage, Male Body Attitudes Scale–Revised (MBAS-R), Eating Disorders Examination Questionnaire Short (EDE-QS), and attitudes about anabolic steroid usage - minority sexual orientations are categorized as followed: 68.4 percent exclusively gay/homosexual, 21.4 percent mostly gay/homosexual, 8.4 percent bisexual, 1.1 percent mostly straight/heterosexual, 0.7 percent "other"	Higher social media usage, particularly Facebook, Instagram, and Snapchat, were associated with greater body image concerns and eating disorder symptoms Associations between social media use and muscularity dissatisfaction and eating disorder symptoms were stronger for image-centric (e.g., Instagram) than for nonimage-centric social media platforms (e.g., wordpress)

Imperatori et al., 2022	-721 young adults (504 females, mean age= 24.13) completed questionnaires on demographics, the Bergen Social Media Addiction Scale, the Eating Attitudes Test-26 (i.e., eating disorder symptoms), the Muscle Dysmorphic Disorder Inventory, the Brief Symptom Inventory (measures psychopathological symptoms), the Cut-Annoyed-Guilty-Eye (CAGE) questionnaire (i.e., problematic alcohol use)	Social media addiction-symptoms were positively associated with muscle dysmorphia-related symptoms (i.e., extreme preoccupation with one's appearance, muscularity, and compulsive physical exercise), eating disorder-related symptoms, psychopathological distress, and problematic alcohol use.
Lonergan et al., 2020	- 4209 adolescents (53.15% girls) completed scales on self-report photo investment (i.e., invested effort in posting a selfie to post on social media and monitoring its feedback), manipulation (i.e., extend to which participants edit their selfies prior to posting online) scales, avoidance of posting selfies to social media, investment in others' selfies (i.e., extent to which the individual examine and interact with other peoples' selfies), Eating Disorder Examination Questionnaire, extreme weight control behaviors, weight loss in the past 4 weeks, the K10 Psychological Distress Scale, and the Pediatric Quality of Life Scale Short Form 15	Avoidance of posting selfies and photo manipulation were associated with greater adjusted odds of meeting criteria for clinical/subclinical anorexia Investment in others' selfies was associated with greater adjusted odds of meeting criteria for all eating disorder groups (bulimia, binge-eating disorder, night eating syndrome, unspecified feeding and eating disorder) except clinical and subclinical anorexia nervosa and purging disorder. Adolescent boys were more likely to meet criteria for clinical and subclinical anorexia nervosa in the context of increased avoidance of posting selfies

Table 3.8 Relationships of social media usage with body image perturbations and eating disorders

References	Methods	Findings
Tiggemann and Slater, 2017	- 438 girls (mean age = 13.6 years) completed questionnaires at two time periods when they were in the first two years of high school - participants completed questionnaires on Facebook use and Body Image Concerns	Number of Facebook friends, but not Facebook usage, prospectively predicted greater drive for thinness in a sample of adolescent girls
Butkowski et al., 2019	- 177 female young adult (age 18-30) Instagram users who has posted selfies were recruited from MTurk	Instagram use frequency not associated with greater body dissatisfaction or drive for thinness

	- participants completed questionnaires on: 1) selfie feedback investment (i.e., degree to which participants value feedback on their posted Instagram selfies), body image disturbance, body dissatisfaction, drive for thinness, bulimic tendencies, body surveillance (ex: "during the day, I think about how I look many times"), Instagram usage, and demographics	
Cohen et al., 2017	- 259 women (mean age = 22.97) completed questionnaires on demographics, social media usage, and the Internalisation-General subscale of the Sociocultural Attitudes Towards Appearance Questionnaire–Version 3, Physical Appearance Comparison Scale, The Appearance Evaluation subscale of the Multidimensional Body-Self Relations Questionnaire-Appearance Scales, The Body Surveillance Subscale of the Objectified Body Consciousness Scale, and the Drive for Thinness Subscale of the Eating Disorder Inventory-3	Instagram users scored higher on the body surveillance (e.g., "during the day, I think about how I look many times") scale than non Instagram users Drive for thinness was not associated with time spent on social media but following "health and fitness" Instagram accounts Greater FB appearance exposure (ex: updating one's profile photo and viewing friends' photos) positively associated with greater body surveillance
Hendrickse et al., 2017	- 185 female college students (mean age = 21.04) with an Instagram account completed questionnaires on Instagram photo activity, appear-related comparison on Instagram, Intrasexual Competition Scale, and drive for thinness via subscale from Eating Disorder Inventory	Instagram photo-based activities positively predicted both drive for thinness and body dissatisfaction through the mediating variable of appearance-related comparisons.
Stronge et al., 2015	- 11 017 adults (mean age = 49.23; 6,883 women, 4,134 men) completed questionnaires on demographics, body satisfaction, and Facebook use	FB users reported significantly lower body satisfaction than non-users.
Howard et al., 2017	- 922 female participants (mean age = 21 years old) completed the Body Shape Questionnaire, Eating Disorder Examination Questionnaire, social media usage, and Social Media Reassurance seeking Scale	More frequent FB usage associated with greater body dissatisfaction

Meier and Gray, 2014	- 103 adolescent female students (mean age = 15.4) completed the following questionnaires: demographics and body mass index, Sociocultural Internalization of Appearance Questionnaire for Adolescents, the Physical Comparison Scale (PACS), Weight Satisfaction subscale for Adolescents and Adults, Drive for Thinness subscale on the Eating Disorder Inventor, Self-Objectification Questionnaire, total Internet and Facebook usage, Facebook Appearance-related Exposure	Frequency of FB appearance exposure (i.e., Facebook-photo related activities) activities positively correlated with internalization of the thin ideal, self-objectification, and drive for thinness, and negatively correlated with weight satisfaction
Murray et al., 2016	- 383 (70.2 percent female) undergraduate students (mean age = 23.1 years) who completed self-report questionnaires on social media usage, the Dutch Eating Behavior Questionnaire, and Body Esteem Scale for Adolescents and Adults	Greater use of social media was associated with more weight and appearance dissatisfaction, which was in turn associated with more severe disordered eating.
Santarossa and Woodruff, 2017	147 young adults (55% female, 45% male, age range 18-27) completed a series of online surveys which measured social media usage, problematic social media usage, body image, self-esteem, and eating disorder symptoms	Time spent on social networking sites was positively associated with greater eating disorder symptoms
Tiggemann and Slater, 2014	- 189 girls (mean age = 11.5) completed questionnaires on magazine/television exposure, internet exposure, body image concerns, and dieting behaviors and status	Time spent on these social networking sites positively correlated with internalization of thin idea, body surveillance, and dieting behavior.
Walker et al., 2015	- 128 college-aged women completed questionnaires on disordered eating, Facebook Intensity Scale (i.e., emotional connection to FB and integration of FB into one's daily life), Online Physical Appearance Comparison Scale, Online Fat Talk Scale, body mass index, Beck Depression Inventory II, State-Trait Anxiety Inventory, Multidimensional Perfectionism Scale, (Negative) Urgency, (Lack of) Premeditation, (Lack of) Perseverance, and Sensation Seeking (UPPS-P) Impulsive Behavior Scale: Negative Urgency, General Self-Efficacy Scale	FB intensity associated with increased online physical appearance comparison, which in turn was associated with greater disordered eating

Yellowlees et al., 2019	A total of 152 females (mean age = 22.4 years) with ED symptoms of clinical severity completed self-report questionnaires on: social media use, selfie-behavior, Eating Disorder Examination Questionnaire, body mass index, Body Dissatisfaction subscale of the Eating Disorder Inventory, Body Checking Questionnaire, Body Image Avoidance Questionnaire, the Rosenberg's Self Esteem Scale	Higher levels of social media usage positively correlated with eating disorder symptoms Greater offline selfie-taking correlated with greater eating disorder symptom severity via greater body checking behaviors
Tiggemann and Anderberg, 2020	- 305 women (mean age = 25.3 years) recruited from TurkPrime were randomly assigned to viewing one of three sets of Instagram images: "Instagram vs reality" images (curated and realistic images were paired side-by-side", "idealized" image side only, or realistic images side only. Participants also completed questionnaires on social networking usage, body dissatisfaction, body appreciation (ex: "despite my flaws, I accept my body for what it is"), 3-item State Appearance Comparison Scale of Tiggemann and McGill (2004)	Viewing "idealized" and curated Instagram images was associated with increases in body dissatisfaction, but not the "Instagram vs reality" images (where the curated and realistic images were put side by side) or the realistic images
Turner and Lefevre, 2017	- 680 women (mean age = 24.7) completed online surveys on social media use, dietary choices, orthorexia nervosa questionnaire (ORTO-15), and demographics	Higher Twitter and Instagram use were associated with increased orthorexia nervosa symptoms
Sidani et al., 2016	- 1765 participants completed questionnaires on eating concerns (i.e., eating disorder symptoms), social media usage, and demographics	Both volume (i.e., time per day) and frequency of social media use (i.e., visits per week) were positively associated with self-reports of eating concerns (i.e., preoccupation with food, dysfunctional eating patterns, preoccupation with one's weight) in a sample of young adults
Mabe et al., 2014	- study one: 1960 college-aged (mean age = 18.4) women completed self-report questionnaires on Facebook use and disordered eating (Eating Attitude Test-26)	FB use positively associated with greater disordered eating Participants with greater eating disorder symptoms placed greater importance of receiving "likes" and comments on status, and more likely to compare their own photos to female friends' photos

	- study two: 84 women, from study 1, who identified as weekly Facebook users, were randomly assigned to use Facebook for an alternate site for 20 minutes. Participants also completed surveys on demographics, preoccupation with weight/scale/shape, and State Trait Anxiety Inventory State scale	

Autism and Social Media Usage

Autism is a neurodevelopmental disorder characterized by decreased mentalistic cognition (Baron-Cohen et al., 1985) and reduced social interest (Chevallier et al., 2012). As discussed previously, autistic traits are expected to be associated with decreased social media usage, as they involve reduced social interests and social interactions (Chevallier et al., 2012; Deckers et al., 2014). Furthermore, when individuals with autistic traits do use social media, it should be for non-social (i.e., mechanistic) purposes, such as sharing factual information on topics of special interests.

Table 3.9. Relationships between social media usage and autistic traits/ autism spectrum conditions

References	Methods	Main Findings
Mazurek et al., 2012	- Parents of the following groups of youths (age 13-17): (1) autism, (2) speech/language impairment, (3) learning disability, (4) intellectual disability, self-reported their children's screen-based media use. - 920 participants with ASD, 860 participants with speech/language impairments, 880 participants with learning disability, and 850 participants with mental retardation	- compared to all other groups, the group with ASD spent most of their time on non-social media (ex: TV, video games), despite being the group with the highest rate of having a computer at home - 64.4% of youths with ASD did not use e-mail or chat-rooms, similar to the mental retardation group (64.4%) but twice as high compared to 33.5% of the speech/language impairment group and 34.9% of the learning disability group
MacMullin et al., 2016	- 172 parents of typically developing children (mean age = 11.72) and 139 parents of children with an ASD diagnosis (mean age = 12.25) report on their children's electronic usage	- individuals with ASD spent less time using electronics for social activities (ex: using social networking sites, using chat rooms, texting/messaging/ talking on cellphone, emailing) compared to NT individuals

		- individuals with ASD spent more time using electronic devices (ex: laptop, desktop, iphone/smartphone, tablet devices) than the NT individuals - individuals with ASD spent more time on the Internet (ex: websurfing, search engine, watching videos, creating webpages, download music files) and general computer activities (ex: creating documents for school, editing images, using photo editing programs) than the NT group
Mazurek and Wenstrup, 2013	- TV, video game and social media usage were compared between children with ASD (N = 202, mean age = 12.1 years) and typically developing siblings (N = 179, mean age = 12.5) via parent self-reports. Majority of sample was Caucasian (88.6%)	- children with ASD spent less time using social media than TD individuals
Durkin et al., 2010	- Self-report cellphone usage is compared between adolescents with Asperger Syndrome (N = 35, 28 Males, 7 females, mean age = 14.2yr) to neurotypical adolescents (N = 35, 29 males, 6 females, mean age = 14.4 yr)	- The ASD group had lower cell phone access compared to the NT group - individuals with ASD ranked "phone friends" significantly lower for cellphone use compared to the NT individuals - individuals with ASD ranked "play games" as a function for cellphone use higher than TD group
Paulus et al., 2020	- Frequency of computer gaming and 'computer-mediated communication' (CMC) (ex: electronic devices for communication purposes, such as FB/Instagram/messaging apps) was compared between 62 boys with ASD (mean age = 11.5) and 31 healthy control boys (mean age = 11.5) via parental reports. - Computer gaming and CMC usage were NOT pooled together.	- ASD boys used CMC less frequently than controls - For the ASD group, the top three CMC used were WhatsApp, Skype, and Youtube. The control group reported similar preferences except Youtube was not a top preference

Suzuki et al., 2021	- two surveys were administered to two separate groups of participants to investigate the relationships between autistic traits, loneliness, social media and LINE usage (note: LINE is a popular messaging app primarily used in Asia) - survey one: 341 students (100 men, 241 women, mean age = 20.0) at a Japanese university completed questionnaires on their social media usage, Autism Quotient – Japanese version, and the Japanese version of University of California, Los Angeles Loneliness Scale-Version 3 (UCLA-LS3) - survey two: a total of 388 undergraduate students (145 men, 213 women, mean age = 19.40) completed a LINE use questionnaire (LINE is a popular messaging apps used in Asia), AQ-Japanese version, and the UCLA-LS3	Numbers of friends and informal groups on LINE were found to have significant negative correlations with both ASD traits and loneliness Instagram use negatively correlated with loneliness and ASD traits (i.e., higher ASD traits, lower INSTA use) Low AQ-social skills scores were found to have a positive association with inactive use of LINE (i.e., only use LINE when have a specific reason to do so").
Begara Iglesias et al., 2019	- Social media usage and experiences of cyberbullying were compared between three groups: (1) Neurotypical (n = 105, 43.8% male, mean age = 15), (2) Individuals diagnosed with ASD (n = 31, 74.2% male, mean age = 15), and (3) individuals with intellectual disability (N= 45, 60% male, mean age = 19)	- 64.5% of the people with ASD used social media, compared to 96.2% of the neurotypical group and 82.2% of the group with intellectual disability = 76.7% of group with ASD used Whatsapp, compared to 91.1% of the group with intellectual disability and 96.2% of the neurotypical group - group with ASD had fewer Whatsapp groups compared to the neurotypical group - Compared with the neurotypical group, the ASD group were less likely to use tablets/cellphone/computer to "talk with friends"

		- The group with ASD was the least likely to use social media to "communicate with friends" compared to the neurotypical group and the group with intellectual disability
Alhujaili et al., 2022	- 26 adolescents (age 13-18) with ASD (23 male and 3 female) and 24 non-ASD adolescents (3 male, 20 female) completed a questionnaire on their social media usage	No differences in average time spent on social media daily between ASD group and non-ASD group; however, 35% of adolescents with ASD spend more than five hours per day on social media compared to 18% of non-ASD adolescents The most preferred social media site for ASD adolescents was Youtube, and Snapchat was preferred in the non-ASD group About 92% of non-ASD participants reported social interaction as reason for using social media compared only 7.7% of participants with ASD; in contrast, 59% of ASD participants reported entertainment as their purpose of using social media
van der Aa et al., 2016	- 113 individuals with ASD 55.9% men, mean age = 40.2) and 72 control individuals (38.9% men, mean age = 40.5) completed questionnaires on internet and computer-mediated-communication use, well-being scales (i.e., self-report satisfaction with one's online and in-person social life), and the Autism Quotient	Compared to controls, individuals with ASD spend more time on computer-mediated communication Out of all CMC channels, people with ASD used discussion sites more frequently than controls

As summarized in Table 3.9, current data indicates that social media usage is generally decreased in ASD relative to the neurotypical population (Mazurek et al., 2012; MacMullin et al., 2016; Mazurek and Wenstrup, 2013; Paulus et al., 2020; Suzuki et al., 2021; Begara Iglesias et al., 2019; Alhujaili et al., 2022).

As consistent with real-life behaviors (where individuals with autism tend engage in decreased social interactions or less socially motivated), individuals with autism were also less likely to use phones to call friends or family (Begara Iglesias et al., 2019), preferring to use phones for games rather than to contact intimate others (Durkin et al., 2010), and they were more likely to report using social media for entertainment purposes than social interactions (Alhujaili et al., 2022). Furthermore, approximately twice as many youths with ASD did not use e-mail or chatrooms, compared to speech/language impairment and learning disability groups (Mazurek et al., 2012), which suggests it is not learning or speech impairments that lead to decreased social media usage, but reduced social interest. Accordingly, relative to controls, individuals with ASD have been shown to be more likely to perceive the isolated context, asynchronous timing, and absence of non-verbal cues of social media platforms as an advantage rather than disadvantage (van der Aa et al., 2016). Given the above findings, the current data supports the hypothesis that individuals with autistic traits may use social media usage less frequently due to decreased social interest, as consistent with the real-life behaviors of the autistic phenotype.

Finally, Paulus et al. (2020) found that boys with autism reported Youtube as one of their top three preferred social media platforms, a preference not expressed by the neurotypicals control group. Adolescents with ASD also preferred Youtube, compared to Snapchat in neurotypicals (Alhujaili et al., 2022). Given that Youtube has historically lacked socially interactive features such as live chat/streaming and only involved relatively solitary and asynchronous activities such as video uploading/watching, individuals with ASD may prefer Youtube for its relatively isolative functions. However, given that there are only two studies investigating social media platform preferences between the ASD and neurotypical populations, additional research is needed on this question.

Although most studies indicate that social media usage is decreased in individuals with ASD, one study has found that individuals with ASD spent more time on computer mediated communication (email, Twitter, instant messaging, social networking sites, discussion sites/forums, dating sites, games) than neurotypicals (van der Aa et al., 2016). In the same study, individuals with autism also report using discussion sites, which tend to be more factually driven and less socially oriented, more than neurotypicals. Taken together, the data thus suggest that when individuals with ASD use

social media, it may often be to communicate factual rather than social information. However, more studies are needed to fill substantive gaps in this area.

3.5. Discussion

The main results of this review are threefold. First, highly mentalistic traits, including paranoia, erotomania, ideas of reference, and other aspects of positive schizotypy, appear to exhibit notable associations with high social media use. The causes of these links appear to involve features of virtual social environments, especially those that support imaginative social cognition. These links may also be bidirectional in that (1) the virtual social environments created by social media platforms may facilitate the expression and exacerbation of social delusions and social-cognitive reality distortions, while, at the same time, and (2) more highly mentalistic individuals may be differentially drawn to social media because it provides scope and supportive conditions for delusional and distorted thinking (Figure 1). This framework goes beyond the view that social media represents a problematic environment that can promote particular forms of mental illness and distress, to suggest that individual psychological makeups interact closely with features of virtual social worlds, especially in the context of high levels of different manifestations of mentalistic cognition. The hypotheses represented by Figure 1 can be evaluated further using controlled experiments, and longitudinal studies, that seek to parse the direction, or directions, of causation.

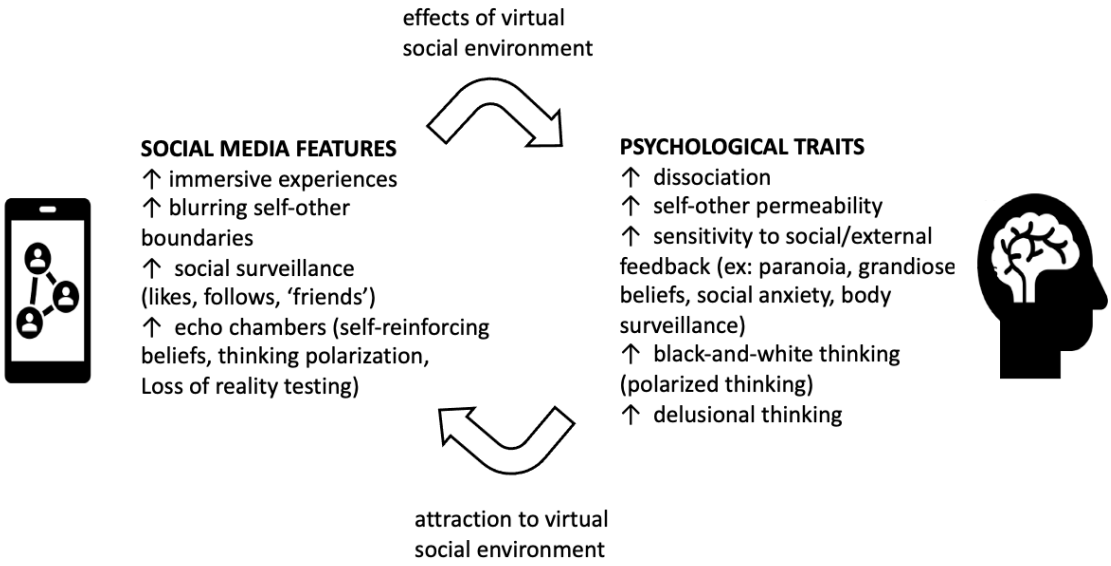

Figure 3.1 A simplified model of how features of social media may interact with human psychological traits, especially those involving high levels of mentalistic cognition

Second, the analysis of psychiatric disorders in relation to social media use also provides evidence that psychotic spectrum disorders involve relatively high levels of this behavior, though the data are, for some disorders (including schizophrenia, schizotypal personality disorder, and bipolar disorder), sparse given the prominent roles that social media and internet use play in contemporary society. Despite these limitations, there is notable evidence that high social media usage is most strongly and consistently associated with a small set of disorders that involve psychotic traits (especially delusions): narcissistic personality disorder, body dysmorphic disorder, and eating disorders. Why should this be so?

We suggest a simple framework, that we refer to as the Delusion Amplification by Social Media (DASM) model, whereby NPD, BDD, eating disorders and, apparently erotomania, all centrally involve forms of mentalistic delusions, linked with altered perception and perpetuation of distorted manifestations of the self, that are specifically and especially enabled and exacerbated by social media, though in different ways with different emotional valences (Figure 2). In particular, an underdeveloped and incoherent sense of self, in conjunction with ‘real life’ social isolation that inhibits identify formation and facilitates virtual social interactions, leads to use of social media to generate and maintain a more or less delusional sense of self identity. The delusions involved may be mental (as in narcissism and erotomania), or somatic (as in BDD and eating disorders, encompassing either the entire body or specific parts). In each case, the virtual nature of social media facilitates the delusions because the self can be mentally defined and bolstered in this highly mentalistic environment, where face to face scrutiny, and potential real-life exposure of the delusion, are largely avoided.

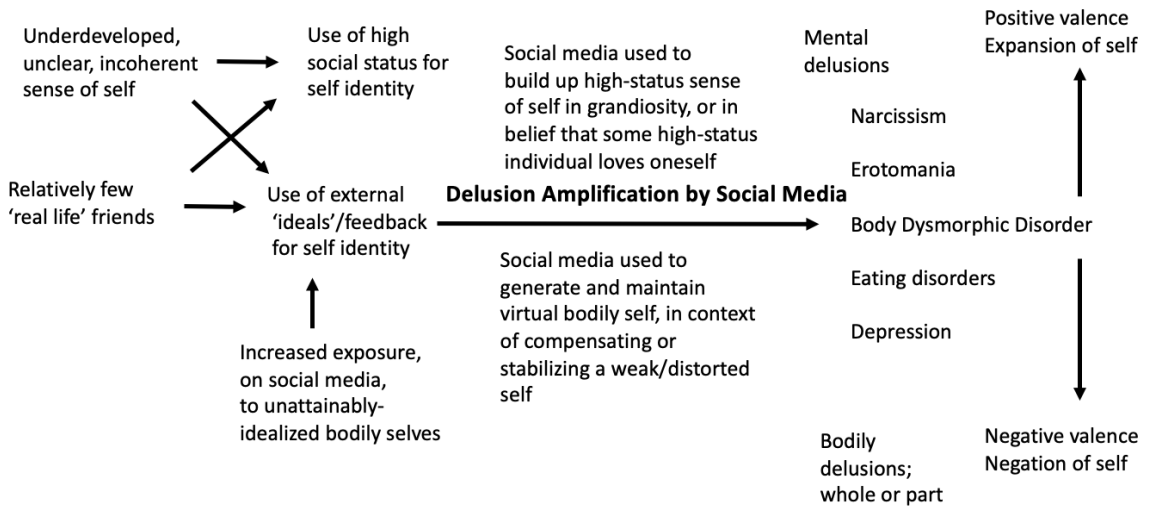

Figure 3.2 The delusion amplification by social media model, for helping to explain high rates of social media use in disorders involving positive schizotypy, erotomania, narcissism, BDD, and eating disorder

The specifics of the DASM model depend on the disorder. Thus, in individuals with Narcissistic Personality Disorder, the self becomes over-expanded and grandiose in terms of gaining high status (Grapsas et al., 2020) (sometimes in association with underlying mental vulnerabilities) and exaggerated positive self-perception (i.e., positive self illusion) (Gabriel et al., 1994; Bleske-Rechek et al., 2008). Indeed, narcissistic traits have been associated with a greater likelihood of perceiving social "others" as extension of oneself, and a greater likelihood of objectifying others for self-gratification (Lachowicz-Tabaczek et al., 2021). Accordingly, narcissistic individuals tend to seek romantic partners for their self-enhancement value instead of relationship quality (i.e., as "trophy" spouse vs emotional intimacy (Campbell, 1999; Tanchotsrinon et al., 2007), and choosing friends for self-enhancement purpose (e.g. status, attractiveness, "makes me feel good") (Jonason and Schmitt, 2012), all of which reflect tendencies of perceiving social "others" as instrumental objects for self-gratification, rather than as separate individuals with their own feelings, beliefs, or wants. In addition, narcissism is associated with greater exhibitionistic behaviors on social media, such as increased status updates, selfies, and more online friends/followers (Table 3.10), which is consistent with the behaviors of an overly idealized self presented to a positive social gaze. Considered together, these findings suggest that the perception of social connection and surveillance, the main functions of most social media platforms, serves to amplify and

mirror back an over-idealized self to the narcissistic individual, which further increases an inflated self-perception that incentivizes increased social media use.

In contrast to NPD, BDD and eating disorders are usually associated with negative affect, anxiety, distress, and high levels of body dissatisfaction. If increased social media usage involves increased anxiety and distress among the individuals with BDD or eating disorders, what would explain their increased usage?

BDD and eating disorders have been characterized as involving distorted or reduced senses of self, with weakened self-other boundaries, diminished autonomy, and high levels of self-body alienation (Strauss and Ryan, 1987; Kaplan et al., 2012, 2014; Crespi and Dinsdale, 2019; Stanghellini et al., 2015). The body is thus commonly perceived and instantiated as an external object that is seen through the eyes of the social "other", rather than being experienced through lived corporality (i.e., via basic self through first-person point of view) (Stanghellini et al., 2012, 2015). This altered perception may cause anxiety from feelings of being scrutinized, but also inadvertently help to define and maintain the basic self-identity that, though distorted, is required for self-coherence and interpersonal functioning. Indeed, some authors have speculated that distorted body image in patients with eating disorders may stem from a weaker experiential self, and thus such patients may be more motivated to seek external and "objective" parameters to instantiate their identity, such as weight (i.e., a numerical value), a mirror (i.e., to check one's reflection), or the gaze of others (i.e., excessive preoccupation of others' opinions) (Gaete and Fuchs, 2016). Regarding the latter, the advent of social media provides a concrete and quantifiable way of objectifying the external social gaze, via "likes", "comments", number of views, and follower/friend counts. Thus, affected individuals may turn to social media usage as a way of instantiating and stabilizing a sense of embodied self by attending to external signals of simulated embodiment, for which social media platforms have specific, curated, online tools. The virtual nature of social media also means that it can also be used in attempts to create and perpetuate a bodily self, lacking in perceived flaws. However, given that the platforms lack the critical component of providing non-mentalistic, real-life perceptual physical stimuli, increased usage may exacerbate, rather than stabilize, increasingly distorted self-images, leading to increased dysmorphia and eating disorder symptoms rather than their mitigation.

Narcissism, erotomania, BDD, and eating disorders thus appear to share a set of key developmental risk factors, involving formation of an underdeveloped and/or incoherent sense of self, and be similarly facilitated by social media use, through its ability to perpetuate mental or somatic delusions that sustain the altered structure of self identity. The specific forms and demographics of these delusions can also be contextualized in the framework of human life histories, in that (1) male reproductive success is strongly enhanced by high social status (Gibson and Mace, 2007; Hopcroft, 2006; Von Rueden et al., 2011) as well as muscular body form (Lidborg et al., 2020), whereas female reproductive success is associated with physical beauty (Pflüger et al., 2012; Jokela, 2009) and high reproductive value and nubility (Lassek and Gaulin, 2019), as well as having a high-status mate (Bereczkei and Csanaky, 1996). In accordance with these findings from studies of human behavior and reproduction, NPD is highly male-biased (Trull et al., 2010), eating disorders and erotomania are highly female-biased (Mitchison and Hay, 2014; Brüne, 2003), and BDD, which involves beauty-related traits in females but muscle-related traits in males (Schneider et al., 2019) shows a relatively unbiased gender ratio.

Narcissism, erotomania, BDD, and eating disorders all also represent forms of delusionality, and thus psychotic conditions and disorders, though their symptoms and intensity are highly variable across individuals. They can, however, be conceptualized along a spectrum that, at its extreme, involves high levels of self-other permeability (Fuchs, 2015), literal ‘dis-integration’ of the basic self, and first-rank psychotic symptoms whereby the basic experiential sense of agency and body ownership are externalized and projected outward (Sass and Parnas, 2003).

The above considerations in no way deny the roles of social media in directly exacerbating BDD and eating disorders through evolutionarily-novel, culture-based effects on striving for unrealistic bodily ideals of thinness or beauty (e.g., Perloff, 2014). Instead, they provide simple, testable models for helping to explain by social media use is notably associated with this small, specific set of psychiatric traits and conditions.

Although depression has not been addressed in any detail in this review, it can also be considered in the context of the DASM model, given the large body of literature on the relationship between increased social media usage and depression (e.g., Yoon et al., 2019; Shensa et al., 2018; Primack et al., 2021; Blease, 2015). Although depression is

normally conceptualized as a mood disorder (American Psychiatric Association, 2013), recent evidence suggest that it may also be considered a disorder of embodiment (Fuchs, 2005; Doerr-Zegers et al., 2017). As with other conditions of bodily delusions (e.g., body dysmorphia, eating disorders), patients with depression experience symptoms suggestive of a diminished or negated sense of self (i.e., feeling of unworthiness, emptiness, social withdrawal, low self-worth) (Kopala-Sibley and Zuroff, 2020), or an overly porous self-other boundary where the individual with depression tend to over-identify with another person's distress (i.e., excessive "empathy") and consequently experience inappropriate self-blame (O'Connor et al., 2007). Indeed, depression is also characterized by excessive mentalizing emotions such as guilt and shame (Gambin and Sharp, 2018; Zahn et al., 2015), both of which involve simulating and internalizing the mental state of the social "other" in self-evaluations (Leith and Baumeister, 1998; Fuchs, 2002). Taken together, these considerations suggest that, as with other self-delusions (e.g., body dysmorphia, eating disorders), depression may also be associated with increased social media usage via its other-centered cognitive orientation (O'Connor et al., 2007), which manifests itself, in part, in terms of maladaptive upward virtual social comparison (Appel et al., 2016).

Although evidence for effects of social media and internet use on liability to psychosis *per se* (as in schizophrenia or bipolar 1 disorder) comes only from case reports, rather than from quantitative analyses, multiple congruent reports of internet or social media-related psychosis have been reported in schizophrenia patients who were spending extreme amounts of time online in lieu of real-life social interactions, with psychotic symptoms involving ideas of reference in online content, magical thinking, and loss of body or thought ownership or agency. These reports suggest a degree of enmeshment between the self vs. non-self in virtual mental spaces, where basic thought, agency, and body ownership are externalized to virtual others. In this context, social media can be seen as presenting an evolutionarily novel medium where there is considerable blurring of self-other (i.e., private-public) boundaries, and where much activity is "other-centered" and externally directed (i.e., social surveillance, receiving likes/follows/" friends", curation of photos and online content to be viewed or consumed by an imaginary audience) – all of which may polarize an individual with a more porous sense of self to lose their sense of agency or body/thought ownership.

How might social media platforms increase the prevalence or severity of self-disorders, at least in principle? In conjunction with the DASM model, we propose a hypothetical framework for how disembodied social interactions in the virtual space may lead to failures in reality testing due to loss of inter-corporal coupling (Figure 3). As described above, humans have evolved to socially interact with one another in shared physical and temporal spaces where there is a “to-and-fro” of synchronization and de-synchronization of various intra-corporal states (i.e., facial expressions, emotions) and inter-corporeal states (i.e., mirroring of body language, tone, pace of speech). For example, Fuchs and De Jaegher (2009) observed that it is the dynamic oscillations between embodied attunement (e.g., mirrored body language, emotional co-regulation) and alienation (e.g., conflict, disagreement) that allows social agents to successfully interact with one another in individuated states. In this view, the lack of desynchronization, or “perfect synchronization”, of algorithm-driven social media feeds into its individual user’s activity and preferences may lead to a collapsed “undifferentiated, homogeneous feeling state” (Fuchs and De Jaegher, 2009, p. 471), or the loss of self-other boundary, manifesting in the type of psychotic symptoms summarized in Tables 3.3 and 3.4.

In the context of this framework, clinical reports of internet or social-media related psychosis commonly follow a pattern that starts with real-life social isolation (decoupling of self from one’s physical social world), increasing usage of online social activities in lieu of real-life social interactions, and prodromal symptoms such as ideas of reference, and magical thinking. Then, in high-risk individuals, full blown psychotic beliefs may develop, where the patient experiences a loss of boundaries between self (internal) or non-self (external) environment, leading to a variety of delusions such as erotomania, paranoia, being controlled/followed, and conspiratorial plots (Sayar and Senkal, 2014; Krishna et al., 2013; Kalbitzer et al., 2014; Lerner et al., 2006; Bell et al., 2005; Nitzan et al., 2011), all of which involve a blurring of self-other boundaries, which is commonly to individuals with psychosis or schizophrenia (Noel et al., 2017; Lee et al., 2021). Furthermore, unlike real-life exchanges, online social interactions lack the physical component of shared inter-corporal co-regulation, which may lead to a positive feedback loop whereby an individual increasingly turns to the online world (in lieu of the real one) for reality-testing but becomes increasingly distressed and entrenched in pre-conceived distorted self-images due to lack of embodied stimuli that would normally co-regulate in-person exchanges (Figure 3.3). In line with this view, individuals with body dysmorphia

or disordered eating symptoms tend to experience greater symptom severity with increased usage (Table 3.7, Table 3.8). Again, additional quantitative data is needed to evaluate this model of how increased social media usage may lead to disorders of disembodiment.

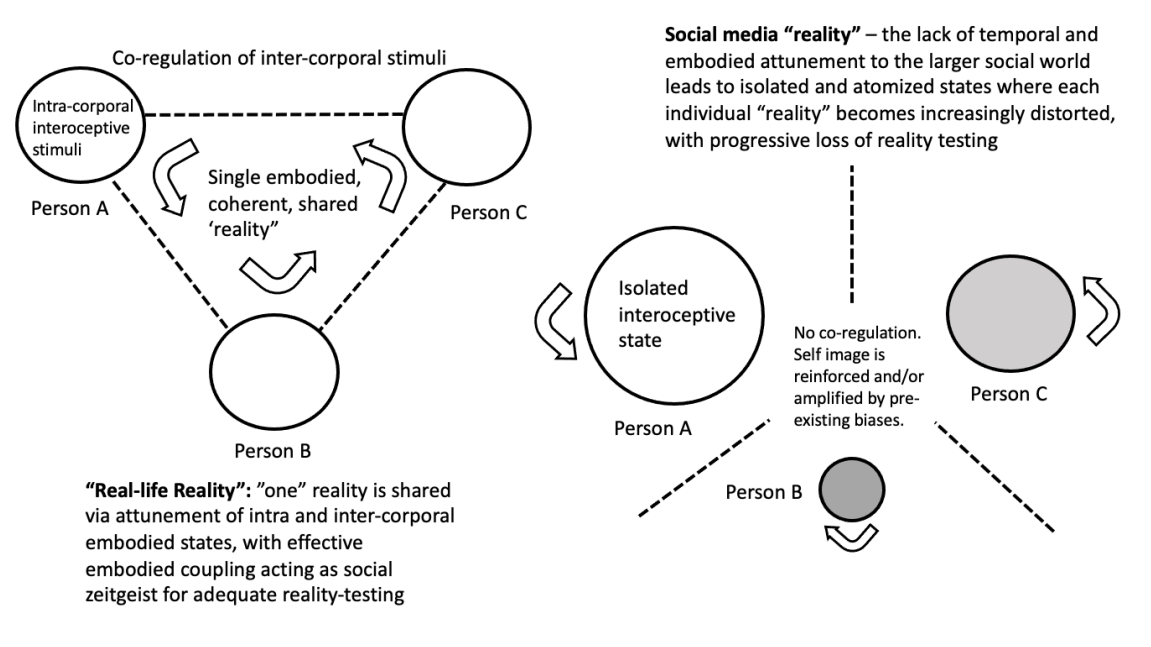

Figure 3.3 A model for how social media alters the nature of realities in the context of self-other interactions

The third main finding of this study is that individuals on the autism spectrum show evidence, albeit mixed, of decreased social media use, and altered, less-mentalistic use of social media platforms. Individuals on the autism spectrum show evidence of being less 'other' and more 'self' oriented, with stronger self-other boundaries (Crespi and Dinsdale, 2019; Noel et al., 2017), which are reflected its patterns of decreased social media usage (Mazurek et al., 2012; MacMullin et al., 2016; Mazurek and Wenstrup, 2013; Paulus et al., 2020; Suzuki et al., 2021; Begara Iglesias et al., 2019; Alhujaili et al., 2022), as well as preferences for the relatively historically solitary platform Youtube (Paulus et al., 2020) instead of Instagram (Suzuki et al., 2021) or Snapchat (Alhujaili et al., 2022). Furthermore, given that Youtube use is relatively more male-biased (Global Media Insight, 2022) than other internet platforms, and has historically involved content focused on special interests, the finding of individuals with autism preferring Youtube

over other forms of social media may be another indicator of less mentalistic cognition among individuals on the autism spectrum.

Multiple lines of evidence also indicate that individuals with ASD utilize social media for more non-social purposes and to avoid difficulties associated with interpreting non-verbal cues in face-to-face exchanges. For example, individuals with ASD have consistently reported preferences for using text-based, asynchronous communication over “traditional” ones as it allows for pacing of responses, minimized non-verbal cues (Benford, 2008; Massier, 2017; Howard and Sedgewick, 2021; Burke et al., 2010) and a sense of interpersonal detachment (i.e., “…can connect with others while maintaining a level of detachment…not worry about physical or in-conversation cues” “…communicate with people …in a format that I am comfortable with – limited emotion – no dumb small talk”) (Mazurek, 2013). Relative to neurotypical individuals, adults with ASD are also less likely to use the internet to connect with family and friends, instead expressing greater enjoyment of using the internet to find similar-minded people for sharing of special interests (Gillespie-Lynch et al., 2014). In additional, individuals with autism also tend to use anonymous public online bulletin boards and blogs more frequently than do controls (Watabe and Suzuki, 2015), which are usually asynchronous and thus suggestive of reduced social interest. Taken together, decreased social media usage in individuals on the autism spectrum disorder appears to reflect decreased interest in social interactions in general, which may be considered a subcomponent of mentalistic cognition.

Finally, given that social media platforms are being increasingly incorporated into everyday life, the increasingly enmeshment between the online vs offline activities may create novel cognitive pressure toward the extended “digital” phenotype; that is, the sense of one’s interpersonal mental and perceptual space being increasingly expanded to include virtual social activities. In this light, the models in Figures 1 to 3 represent different manifestations of interactive positive feedback loops of the evolutionarily novel digital social migration. In other words, the bidirectional relationship between users’ mentalistic traits and social media platforms’ immersive functions create a positive feedback loop where the environment selects for higher expression of mentalistic socio-cognitive phenotypes characterized by weaker self-other boundaries, and vice versa. Individuals with a more porous basic self may gravitate toward social media platforms for their sense of identity, generating positive feedback loops where pre-existing biases or beliefs are entrenched or amplified due to activity patterns of self-attunement. As more

and more social activities become virtualized, fractured and atomized, social media virtual “realities” may emerge as the predominant cognitive ecosystem where each individuals’ social media “reality” becomes more and more decoupled, isolated, and polarized from one another. The decoupling of each user’s social media “reality” may lead to progressive loss of embodied and physical reality testing that humans have evolved for, which may exacerbate or amplify conditions characterized by weak self-other boundaries such as, but not limited to, narcissism, body dysmorphia, eating disorders and psychosis.

Limitations

Findings from this narrative review are constrained by several limitations. First, levels and patterns of social media usage in some disorders, including autism, schizophrenia, schizotypal personality, bipolar I disorder, and anorexia, have been subject to relatively little quantitative study, which limits the strengths of inferences in this regard.

Second, although multiple case reports have focused on individuals with psychosis whose manifestations centre on the internet or social media, quantitative research is needed to elucidate their relationships and evaluate underlying mechanisms. Currently, only case reports are available on the potential relationships between psychosis and social media usage, which makes it difficult to discern whether such casual relationships exist, or if psychotic symptoms were already present prior to increased internet/social media usage.

Third, although most studies examine social media usage as a single construct, certain psychotic spectrum conditions may opt for certain social media functions more frequently than others (for example, narcissism and selfie-taking), and for very different purposes (i.e., admiration or attention seeking in narcissism, body checking in BDD). Future research may consider investigating how usage of different social media platforms (such as image-based Instagram vs text-based Reddit) and their respective functions (such as selfie or passive scrolling) differ across individuals with different psychological makeups.

Fourth, recent studies of social media usage and eating disorders sometimes investigate the latter as a single relatively homogenous construct, which is likely problematic with regard to discerning their links with social media use. As such, although current data in this review point to relationships of social media usage patterns with distorted body

images, and eating disorder symptoms, additional data are needed to evaluate these links in relation to specific eating disorder symptoms, and to see if patterns can be extrapolated to clinical populations, particularly in the case of anorexia.

Furthermore, although the current research paradigm has predominately focused on cultural explanations (i.e., unrealistic beauty standards) for elucidating the relationships between social media, body dysmorphia, and eating disorders, current data indicates that they may also conceptualized as disorders of embodiment, of which the body image is a symptom, rather than the cause, of pathological eating patterns and/or somatosensory perception.

Conclusions

According to Cooley's (1902) theory of the looking-glass self, people's self-identities are formed in three steps: (1) people imagining how they appear to other people, (2) people imagining how others are judging them based on appearance and how they present themselves, and (3) people imagining how others feel about them based on the judgements they make. Considering modern technological advances, the reflecting power of another person's eyes is being replaced by the glow of smartphone screens displaying virtual faces and bodies. For the first time in human evolutionary history, social interactions can thus be completely disembodied and dissociated from its physical, temporal, and tactile cues.

The studies and conceptual frameworks described here suggest that social media use is associated with higher levels of mentalistic cognition in general, and specific mentalistic disorders characterized by symptoms of perturbed embodiment, and we suggest reasons why this may be so. Further, targeted studies, designed to test theories and directionalities of causation, are required to better understand the societal and psychological effects of our novel, virtual, looking-glass world.

3.6. References

Aardema, F., O'Connor, K., Côté, S., and Taillon, A. (2010). Virtual reality induces dissociation and lowers sense of presence in objective reality. Cyberpsychol. Behav. Soc. Netw. 13(4), 429–435. doi:10.1089/cyber.2009.0164

Piaget, J. (1962) Play, Dreams, and Imitation in Childhood, Norton 2.

Haight, W. and Miller, P.J. (1993) Pretending at Home: Early Development in a Sociocultural Context, State University of New York Press

Lillard, A. S. (2017). Why do the children (pretend) play?. *Trends in Cognitive Sciences*, *21*(11), 826-834. doi:10.1016/j.tics.2017.08.001

Akça, Ö.F., Bilgiç, A., Karagöz, H., Çikili, Y., Koçak, F., and Sharp, C. (2020). Social media use and personality disorders. Anadolu Psikiyatri Derg. 21(3). doi:10.5455/apd.58500

Alhujaili, N., Platt, E., Khalid-Khan, and S., Groll, D. (2022). Comparison of social media use among adolescents with Autism Spectrum Disorder and non-ASD adolescents. Adolesc. Health Med. Ther. 13, 15. doi:10.2147/AHMT.S344591

Alloway, T., Runac, R., Quershi, and M., Kemp, G. (2014). Is Facebook linked to selfishness? Investigating the relationships among social media use, empathy, and narcissism. Soc. Netw. 3(3), 150–158. doi:10.4236/sn.2014.33020

Alsaidan, M.S., Altayar, N.S., Alshmmari, S.H., Alshammari, M.M., Alqahtani, F.T., and Mohajer, K.A. (2020). The prevalence and determinants of body dysmorphic disorder among young social media users: a cross-sectional study. Dermatol. Reports 12(3). doi:10.4081/dr.2020.8774

American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders. 5. Washington, DC: American Psychiatric Association.

Andreassen, C.S., Pallesen, S., and Griffiths, M.D. (2017). The relationship between addictive use of social media, narcissism, and self-esteem: findings from a large national survey. Addict. Behav. 64, 287–293. doi:10.1016/j.addbeh.2016.03.006

Appel, H., Gerlach, A.L., and Crusius, J. (2016). The interplay between Facebook use, social comparison, envy, and depression. Curr. Opin. Psychol. 9, 44–49. doi:10.1016/j.copsyc.2015.10.006

Arpaci, I., Yalçın, S.B., Baloğlu, M., and Kesici, Ş., (2018). The moderating effect of gender in the relationship between narcissism and selfie-posting behavior. Personal. Indiv. Diff. 134, 71–74. doi:10.1016/j.paid.2018.06.006

Auxier, B., and Anderson, M., (2021). Social media use in 2021. Pew Res. Center 1, 1-4.

Baek, Y.M., Bae, Y., and Jang, H. (2013). Social and parasocial relationships on social network sites and their differential relationships with users' psychological well-being. Cyberpsychol. Behav. Soc. Netw. 16(7), 512–517. doi:10.1089/cyber.2012.0510

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., and Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 364(1522), 1377–1383. doi:10.1098/rstb.2008.0337

Baron-Cohen, S., Leslie, A.M., and Frith, U. (1985). Does the autistic child have a "theory of mind"? Cognition 21(1), 37–46. doi:10.1016/0010-0277(85)90022-8

Baron-Cohen, S., Lombardo, M.V., Auyeung, B., Ashwin, E., Chakrabarti, B., and Knickmeyer, R. (2011). Why are autism spectrum conditions more prevalent in males? PLoS Biol. 9(6), e1001081. doi:10.1371/journal.pbio.1001081

Begara Iglesias, O., Gómez Sánchez, L.E., and Alcedo Rodríguez, M.A. (2019). Do young people with Asperger syndrome or intellectual disability use social media and are they cyberbullied or cyberbullies in the same way as their peers? Psicothema 31(1), 30–37. doi:10.7334/psicothema2018.243

Bell, V., Grech, E., Maiden, C., Halligan, P.W., and Ellis, H.D. (2005). 'Internet delusions': a case series and theoretical integration. Psychopathology 38(3), 144–150. doi:10.1159/000085845

Benford, P. (2008). (Unpublished results). The use of Internet-based communication by people with autism (Doctoral dissertation). University of Nottingham. Retrieved from http://etheses.nottingham.ac.uk/661/

Bereczkei, T., and Csanaky, A. (1996). Mate choice, marital success, and reproduction in a modern society. Ethol. Sociobiol. 17(1), 17–35. doi:10.1016/0162-3095(95)00104-2

Bergman, S.M., Fearrington, M.E., Davenport, S.W., Bergman, J.Z. (2011). Millennials, narcissism, and social networking: what narcissists do on social networking sites and why. Personal. Indiv. Diff. 50, 706–711. http://doi.org/10.1016/j.paid.2010.12.022

Berry, N., Emsley, R., Lobban, F., Bucci, S. (2018). Social media and its relationship with mood, self-esteem and paranoia in psychosis. Acta Psychiatr. Scand. 138(6), 558–570. doi:10.1111/acps.12953

Bibby, P.A. (2008). Dispositional factors in the use of social networking sites: findings and implications for social computing research, in: International Conference on Intelligence and Security Informatics, pp. 392–400. doi:10.1007/978-3-540-69304-8_40

Biolcati, R., and Passini, S. (2018). Narcissism and self-esteem: different motivations for selfie posting behaviors. Cogent Psychol. 5(1), 1437012. doi:10.1080/23311908.2018.1437012

Blease, C.R. (2015). Too many 'friends,' too few 'likes'? Evolutionary psychology and 'Facebook depression'. Rev. Gen. Psychol. 19(1), 1–13. doi:10.1037/gpr0000030

Bleske-Rechek, A., Remiker, M.W., and Baker, J.P. (2008). Narcissistic men and women think they are so hot–But they are not. Personal. Indiv. Diff. 45(5), 420–424. doi:10.1016/j.paid.2008.05.018

Bond, B.J. (2016). Following your "friend": social media and the strength of adolescents' parasocial relationships with media personae. Cyberpsychol. Behav. Soc. Netw. 19(11), 656–660. doi:10.1089/cyber.2016.0355

Brüne, M. (2003). Erotomanic stalking in evolutionary perspective. Behav. Sci. Law. 21(1), 83–88. doi:10.1002/bsl.518

Buffardi, L.E., and Campbell, W.K. (2008). Narcissism and social networking web sites. Pers. Soc. Psychol. Bull. 34(10), 1303–1314. doi:10.1177/0146167208320061

Burke, M., Kraut, R., and Williams, D. (2010). Social use of computer-mediated communication by adults on the autism spectrum, in: Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, pp. 425–434. doi:10.1145/1718918.1718991

Butkowski, C.P., Dixon, T.L., and Weeks, K. (2019). Body surveillance on Instagram: examining the role of selfie feedback investment in young adult women's body image concerns. Gender Roles 81(5–6), 385–397. http://doi.org/10.1007/s11199-018-0993-6

Campbell, W.K. (1999). Narcissism and romantic attraction. J. Pers. Soc. Psychol. 77(6), 1254. doi:10.1037/0022-3514.77.6.1254

Canan, F., Ataoglu, A., Ozcetin, A., and Icmeli, C. (2012). The association between Internet addiction and dissociation among Turkish college students. Compr. Psychiatry 53(5), 422–426. doi:10.1016/j.comppsych.2011.08.006

Carpenter, C.J. (2012). Narcissism on Facebook: self-promotional and anti-social behavior. Personal. Indiv. Diff. 52(4), 482–486. doi:10.1016/j.paid.2011.11.011

Catalano, G., Catalano, M.C., Embi, C.S., and Frankel, R.L. (1999). Delusions about the Internet. South. Med. J. 92, 609–610. doi:10.1097/00007611-199906000-00010

Charlton, B., McClelland, H.A. (1999). Theory of Mind and the delusional disorders. J. Nerv. Ment. Dis. 187(6), 380–383. doi:10.1097/00005053-199906000-00009

Charoensukmongkol, P. (2016). Exploring personal characteristics associated with selfie-liking. Cyberpsychology 10(2). doi:10.5817/CP2016-2-7

Chen, G.M. (2014). Revisiting the social enhancement hypothesis: extroversion indirectly predicts number of Facebook friends operating through Facebook usage. Comput. Hum. Behav. 39, 263–269. doi:10.1016/j.chb.2014.07.015

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E.S., and Schultz, R.T. (2012). The social motivation theory of autism. Trends Cogn. Sci. 16(4), 231–239. doi:10.1016/j.tics.2012.02.007

Ciaunica, A., McEllin, L., Kiverstein, J., Gallese, V., Hohwy, J., and Woźniak, M. (2022). Zoomed out: digital media use and depersonalization experiences during the COVID-19 lockdown. Sci. Rep. 12(1), 1–13. doi:10.1038/s41598-022-07657-8

Cohen, R., Newton-John, T., and Slater, A. (2017). The relationship between Facebook and Instagram appearance-focused activities and body image concerns in young women. Body Image 23, 183–187. http://doi.org/10.1016/j.bodyim.2017.10.002

Coid, J., Yang, M., Bebbington, P., Moran, P., Brugha, T., Jenkins, R., Singleton, N., and Ullrich, S. (2009). Borderline personality disorder: health service use and social functioning among a national household population. Psychol. Med. 39(10), 1721–1731. doi:10.1017/S0033291708004911

Compton, M.T. (2003). Internet delusions. South. Med. J. 96(1), 61–63. doi:10.1097/01.SMJ.0000047722.98207.32

Cooley, C.H. (1902). Looking-glass self. The production of reality: Essays and readings on social interaction, 6, 126–128.

Cotterill, J.A. (1981). Dermatological non-disease: a common and potentially fatal disturbance of cutaneous body image. Br. J. Dermatol. 104(6), 611–619. doi:10.1111/j.1365-2133.1981.tb00746.x

Crespi, B., and Badcock, C. (2008). Psychosis and autism as diametrical disorders of the social brain. Behav. Brain Sci. 31(3), 241–261. doi:10.1017/S0140525X08004214

Crespi, B., and Dinsdale, N. (2019). Autism and psychosis as diametrical disorders of embodiment. Evol. Med. Public Health, 2019(1), 121–138. doi:10.1093/emph/eoz021

De Clerambault, G.G. (1942). Les Psychoses Passionelles, in Oeuvere Psychiatrique: Paris: Presses Universities, de France, 331:337–339,357,408.

Deckers, A., Roelofs, J., Muris, P., and Rinck, M. (2014). Desire for social interaction in children with autism spectrum disorders. Res. Autism Spectr. Disord. 8(4), 449–453. doi:10.1016/j.rasd.2013.12.019

Doerr-Zegers, O., Irarrázaval, L., Mundt, A., and Palette, V. (2017). Disturbances of embodiment as core phenomena of depression in clinical practice. Psychopathology 50(4), 273–281. doi:10.1159/000477775

Duffy, B.E., and Chan, N.K. (2019). “You never really know who’s looking”: imagined surveillance across social media platforms. New Media Soc. 21(1), 119–138. doi:10.1177/1461444818791318

Duggal, H.S., Jagadheesan, K., and Nizamie, H.S. (2002). ‘Internet Delusion’ responsive to cognitive therapy. Indian J. Psychiatry. 44(3), 293.

Dunbar, R.I. (2004). Gossip in evolutionary perspective. Rev. Gen. Psychol. 8(2), 100–110. doi:10.1037/1089-2680.8.2.100

Durkin, K., Whitehouse, A., Jaquet, E., Ziatas, K., and Walker, A.J. (2010). Cell phone use by adolescents with Asperger Syndrome. Res. Autism Spectr. Disord. 4(2), 314–318. doi:10.1016/j.rasd.2009.09.017

Earle, K.K. (2018) (Unpublished results). Attributions online: an examination of time stamps, read receipts, and ellipses in text-based communication (Doctoral dissertation). North Dakota State University. doi:10.1145/3025453.3025925

Faden, J., Levin, J., Mistry, R., and Wang, J. (2017). Delusional disorder, erotomanic type, exacerbated by social media use. Case Rep. Psychiatry 2017, 8652524. doi:10.1155/2017/8652524

Fekih-Romdhane, F., Sassi, H., and Cheour, M. (2021). The relationship between social media addiction and psychotic-like experiences in a large nonclinical student sample. Psychosis 1–12. doi:10.1080/17522439.2020.1861074

Fox, J., and Rooney, M.C. (2015). The Dark Triad and trait self-objectification as predictors of men’s use and self-presentation behaviors on social networking sites. Personal. Indiv. Diff. 76, 161–165. doi:10.1016/j.paid.2014.12.017

Frederick, C.M., and Zhang, T. (2019). Narcissism and social media usage: is there no longer a relationship? J. Artic. Support Null Hypothesis 16(1), 23.

Frederick, E.L., Lim, C.H., Clavio, G., and Walsh, P. (2012). Why we follow: an examination of parasocial interaction and fan motivations for following athlete archetypes on Twitter. Int. J. Sport Comm. 5(4), 481–502.

Fuchs, T. (2002). The phenomenology of shame, guilt and the body in body dysmorphic disorder and depression. J. Phenomenol. Psychol. 33(2), 223–243. doi:10.1163/15691620260622903

Fuchs, T. (2005). Corporealized and disembodied minds: a phenomenological view of the body in melancholia and schizophrenia. Philos. Psychiatr. Psychol. 12(2), 95–107. https://www.muse.jhu.edu/article/190379

Fuchs, T. (2015). From self-disorders to ego disorders. Psychopathology 48(5), 324–331. doi:10.1159/000432404

Fuchs, T., and De Jaegher, H. (2009). Enactive intersubjectivity: participatory sense-making and mutual incorporation. Phenom. Cogn. Sci. 8, 465–486. doi:10.1007/s11097-009-9136-4

Gabbard, G.O. (2022). Narcissism and suicide risk. Ann. Gen. Psychiatry 21(1), 3. doi:10.1186/s12991-022-00380-8

Gabriel, M.T., Critelli, J.W., and Ee, J.S. (1994). Narcissistic illusions in self-evaluations of attractiveness and intelligence. J. Personal. 62, 143–155.

Gaete, M.I., and Fuchs, T. (2016). From body image to emotional bodily experience in eating disorders, J. Phenomenol. Psychol. 47(1), 17–40. doi:10.1163/15691624-12341303

Gambin, M., and Sharp, C. (2018). The relations between empathy, guilt, shame and depression in inpatient adolescents. J. Affect. Disord. 241, 381–387. doi:10.1016/j.jad.2018.08.068

Gibson, M.A., and Mace, R. (2007). Polygyny, reproductive success and child health in rural Ethiopia: why marry a married man? J. Biosoc. Sci. 39(2), 287–300. doi:10.1073/pnas.1606800113

Gill, R. (2022). Being watched and feeling judged on social media. Fem. Media Stud. 1–6. http://doi.org/10.1080/14680777.2021.1996427

Gillespie-Lynch, K., Kapp, S.K., Shane-Simpson, C., Smith, D.S., and Hutman, T. (2014). Intersections between the autism spectrum and the internet: perceived benefits and preferred functions of computer-mediated communication. J. Intellect. Dev. Disabil. 52(6), 456–469.

Giordano, C., Salerno, L., Pavia, L., Cavani, P., Coco, G.L., Tosto, C., and Di Blasi, M. (2019). Magic mirror on the wall: selfie-related behavior as mediator of the relationship between narcissism and problematic smartphone use. Clin. Neuropsychiatry 16(5–6), 197. doi:10.36131/clinicalnpsych2019050602

Glaser, J.P., Van Os, J., Thewissen, V., and Myin-Germeys, I. (2010). Psychotic reactivity in borderline personality disorder. Acta Psychiatr. Scand. 121(2), 125–134. doi:10.1111/j.1600-0447.2009.01427.x

Global Media Insight. (2022). Youtube User Statistics. Retrieved from: https://www.globalmediainsight.com/blog/youtube-users-statistics-/ Last accessed Aug 1, 2022.

Grapsas, S., Brummelman, E., Back, M.D., and Denissen, J.J. (2020). The “why” and “how” of narcissism: a process model of narcissistic status pursuit. Perspect. Psychol. Sci. 15(1), 150–172. doi:10.1177/1745691619873350

Griffiths, S., Brennan, L., O’Gorman, B., Goedel, W.C., Sheffield, J., Bastian, B., and Barlow, F.K. (2018). Experiences of weightism among sex minority men: relationships with Body Mass Index, body dissatisfaction, and psychological quality of life. Soc. Sci. Med. 214, 35–40. doi:10.1016/j.socscimed.2018.08.018

Gruzd, A., Mai, P. (2020). The state of social media in Canada 2020. Available at SSRN: https://ssrn.com/abstract=3651206 or http://doi.org/10.2139/ssrn.3651206. Last accessed March 5, 2022.

Hawk, S.T., van den Eijnden, R.J., van Lissa, C.J., and ter Bogt, T.F. (2019). Narcissistic adolescents’ attention-seeking following social rejection: links with social media disclosure, problematic social media use, and smartphone stress. Comput. Hum. Behav. 92, 65–75. doi:10.1016/j.chb.2018.10.032

Hendrickse, J., Arpan, L.M., Clayton, R.B., and Ridgway, J.L. (2017). Instagram and college women’s body image: investigating the roles of appearance-related comparisons and intrasex competition. Comput. Hum. Behav. 74, 92–100. doi:10.1016/j.chb.2017.04.027

Herpertz, S., Steinmeyer, E.M., and Sass, H. (1994). Patterns of comorbidity among DSM-III-R and ICD-10 personality disorders as observed with a new inventory for the assessment of personality disorders. Eur. Arch. Psychiatry. Clin. Neurosci. 244(3), 161–169. doi:10.1007/BF02191892

Hogg, J.L.C. (2009). (Unpublished results). Impact of personality on communication: an MMPI-2 study of African American college students and their choice in the digital communications age (Doctoral dissertation). Fielding Graduate University.

Hopcroft, R.L. (2006). Gender, status, and reproductive success in the contemporary United States. Evol. Hum. Behav. 27(2), 104–120. doi:10.1016/j.evolhumbehav.2005.07.004

Horton, R.S., Reid, C.A., Barber, J.M., Miracle, J., and Green, J.D. (2014). An experimental investigation of the influence of agentic and communal Facebook use on grandiose narcissism. Comput. Hum. Behav. 35, 93–98. doi:10.1016/j.chb.2014.02.038.

Howard, L.M., Heron, K.E., MacIntyre, R.I., Myers, T.A., and Everhart, R.S. (2017). Is use of social networking sites associated with young women’s body dissatisfaction and disordered eating? A look at Black–White racial differences. Body Image 23, 109–113. doi.org/10.1016/j.bodyim.2017.08.008

Howard, P.L., and Sedgewick, F. (2021). Anything but the phone!: communication mode preferences in the autism community. Autism 25(8), 2265–2278. doi:10.1177/13623613211014995

Imperatori, C., Panno, A., Carbone, G.A., Corazza, O., Taddei, I., Bernabei, L., Massullo, C., Prevete, E., Tarsitani, L., Pasquini, M., Farina, B., Biondi, M., and Bersani, F.S. (2022). The association between social media addiction and eating disturbances is mediated by muscle dysmorphia-related symptoms: a cross-sectional study in a sample of young adults. Eat. Weight Disord. 27, 1131–1140. doi:10.1007/s40519-021-01232-2

Ioannidis, K., Taylor, C., Holt, L., Brown, K., Lochner, C., Fineberg, N.A., Corazza, O., Chamberlain, S. R., Roman-Urrestarazu, A., and Czabanowska, K. (2021). Problematic usage of the internet and eating disorder and related psychopathology: a multifaceted, systematic review and meta-analysis. Neurosci. Biobehav. Rev. 125, 569–581. doi:10.1016/j.neubiorev.2021.03.005

Jokela, M. (2009). Physical attractiveness and reproductive success in humans: evidence from the late 20th century United States. Evol. Hum. Behav. 30(5), 342–350. doi:10.1016/j.evolhumbehav.2009.03.006

Jonason, P.K., and Schmitt, D.P. (2012). What have you done for me lately? Friendship-selection in the shadow of the Dark Triad traits. Evol. Psychol. 10, 400–421. doi:10.1177/147470491201000303

Jordan, H.W., Lockert, E.W., Johnson-Warren, M., Cabell, C., Cooke, T., Greer, W., and Howe, G. (2006). Erotomania revisited: thirty-four years later. J. Natl. Med. Assoc. 98(5), 787–793.

Kalbitzer, J., Mell, T., Bermpohl, F., Rapp, M.A., and Heinz, A. (2014). Twitter psychosis: a rare variation or a distinct syndrome? J. Nerv. Ment. Dis. 202(8), 623. doi:10.1097/NMD.0000000000000173

Kaplan, R.A., Enticott, P.G., Hohwy, J., Castle, D.J., and Rossell, S.L. (2014). Is body dysmorphic disorder associated with abnormal bodily self-awareness? A study using the rubber hand illusion. PLoS One 9(6), e99981. doi:10.1371/journal.pone.0099981

Kaplan, R.A., Rossell, S.L., Enticott, P.G., Hohwy, J., and Castle, D.J. (2012). It's beginning to look a lot like my hand: fake hand perceived to resemble own hand for people with body dysmorphic disorder but not controls. Conference Abstract: ACNS-2012 Australasian Cognitive Neuroscience Conference. doi:10.3389/conf.fnhum.2012.208.00055

Kasantikul, D. (1998). Erotomania in Thai patients: a study of 20 cases. J. Med. Assoc. Thai. 81(11), 852–857.

Kelleher, I., and DeVylder, J.E. (2017). Hallucinations in borderline personality disorder and common mental disorders. Br. J. Psychiatry 210(3), 230–231. doi:10.1192/bjp.bp.116.185249

Kelly, B.D. (2005). Erotomania. CNS Drugs 19, 657–669. doi:10.2165/00023210-200519080-00002

Kemp, S. (2015). Digital, social and mobile worldwide in 2015. We Are Social: http://wearesocial.net/blog/2015/01/digital-social-mobile-worldwide-2015/ Last accessed May 30, 2022.

Kircaburun, K., Demetrovics, Z., Király, O., and Griffiths, M.D. (2020). Childhood emotional trauma and cyberbullying perpetration among emerging adults: a multiple mediation model of the role of problematic social media use and psychopathology. Int. J. Ment. Health Addict. 18(3), 548–566. doi:10.1007/s11469-018-9941-5

Kircaburun, K., and Griffiths, M.D. (2018). The dark side of internet: preliminary evidence for the associations of dark personality traits with specific online activities and problematic internet use. J. Behav. Addict. 7(4), 993–1003. doi:10.1556/2006.7.2018.109

Kobayashi, T., Okada, Y., Nisijima, K., and Kato, S. (2001). “Internet delusion” in a patient with a schizoaffective disorder. Can. J. Psychiatry 46(1), 89–90.

Kojouri, C. (2015) (Unpublished results). Using Facebook to self-enhance: narcissism and psychological outcomes (Doctoral dissertation). University of Southampton.

Kopala-Sibley, D.C., and Zuroff, D.C. (2020). The self and depression: four psychological theories and their potential neural correlates. J. Pers. 88(1), 14–30. doi:10.1111/jopy.12456

Krishna, N., Fischer, B.A., Miller, M., Register-Brown, K., Patchan, K., and Hackman, A. (2013). The role of social media networks in psychotic disorders: a case report. Gen. Hosp. Psychiatry 35(5), 576–e1. doi:10.1016/j.genhosppsych.2012.10.006

Kuo, J., and Hwu, H.G. (2007). Internet-related delusional disorder. Taiwan J. Psychiatry 21, 66–71.

Kurtin, K.S., O’Brien, N., Roy, D., and Dam, L. (2018). The development of parasocial interaction relationships on YouTube. J. Soc. Med. Soc. 7(1), 233–252.

Lachowicz-Tabaczek, K., Lewandowska, B., Kochan-Wójcik, M., Andrzejewska, B.E., and Juszkiewicz, A. (2021). Grandiose and vulnerable narcissism as predictors of the tendency to objectify other people. Curr. Psychol. 40(11), 5637–5647. doi:10.1007/s12144-019-00569-3

Lassek, W.D., and Gaulin, S.J. (2019). Evidence supporting nubility and reproductive value as the key to human female physical attractiveness. Evol. Hum. Behav. 40(5), 408–419. doi:10.1016/j.evolhumbehav.2019.05.001

Lee, H.S., Hong, S.J.J., Baxter, T., Scott, J., Shenoy, S., Buck, L., Bodenheimer, B., and Park, S. (2021). Altered peripersonal space and the bodily self in schizophrenia: a virtual reality study. Schizophr. Bull. 47(4), 927–937. doi:10.1093/schbul/sbab024

Leith, K.P., and Baumeister, R.F. (1998). Empathy, shame, guilt, and narratives of interpersonal conflicts: Guilt-prone people are better at perspective taking. J. Pers. 66(1), 1–37. doi:10.1111/1467-6494.00001

Lerner, V., Libov, I., and Witztum, E. (2006). “Internet delusions”: the impact of technological developments on the content of psychiatric symptoms. Isr. J. Psychiatry Relat. Sci. 43(1), 47.

Lidborg, L.H., Cross, C.P., and Boothroyd, L.G. (2022). A meta-analysis of the association between male dimorphism and fitness outcomes in humans. eLife 11, e65031. doi:10.7554/eLife.65031

Lonergan, A.R., Bussey, K., Fardouly, J., Griffiths, S., Murray, S.B., Hay, P., Mond, J., Trompeter, N., and Mitchison, D. (2020). Protect me from my selfie: examining the association between photo-based social media behaviors and self-reported eating disorders in adolescence. Int. J. Eating Disord. 53(5), 755–766. doi:10.1002/eat.23256

Longden, E., Branitsky, A., Moskowitz, A., Berry, K., Bucci, S., and Varese, F. (2020). The relationship between dissociation and symptoms of psychosis: a meta-analysis. Schizophr. Bull. 46(5), 1104–1113. doi:10.1093/schbul/sbaa037

Lynden, J., and Rasmussen, T. (2017). Exploring the impact of ‘read receipts’ in Mobile Instant Messaging. Tidsskrift for Medier, Erkendelse Og Formidling 5(1). https://tidsskrift.dk/mef-journal/article/view/28781

Mabe, A.G., Forney, K.J., and Keel, P.K. (2014). Do you “like” my photo? Facebook use maintains eating disorder risk. Int. J. Eat. Disord. 47(5), 516–523. doi:10.1002/eat.22254

MacMullin, J.A., Lunsky, Y., and Weiss, J.A. (2016). Plugged in: electronics use in youth and young adults with autism spectrum disorder. Autism 20(1), 45–54. doi:10.1177/1362361314566047

Marckmann, S., Garlipp, P., Krampfl, K., and Haltenhof, H. (2005). Genital self mutilation and erotomania. J. Psychiatry 8, 38–41.

Margolese, H.C., Chouinard, G., Beauclair, L., and Miller, R. (2002). Using the rating scale for psychotic symptoms to characterize delusions expressed in a schizophrenia patient with “Internet Psychosis”. Can. J. Psychiatry 47(5), 485–485.

Marshall, T.C., Ferenczi, N., Lefringhausen, K., Hill, S., and Deng, J. (2020). Intellectual, narcissistic, or Machiavellian? How Twitter users differ from Facebook-only users, why they use Twitter, and what they tweet about. Psychol. Pop. Media. Cult. 9(1), 14–30. doi:10.1037/ppm0000209

Martini, T., Czepielewski, L.S., Fijtman, A., Sodré, L., Wollenhaupt-Aguiar, B., Pereira, C.S., Vianna-Sulzbach, M., Goi, P.D., Rosa, A.R., Kapczinski, F., Kunz, M., and Kauer-Sant'anna, M. (2013). Bipolar disorder affects behavior and social skills on the Internet. PLoS One 8(11), e79673. doi:10.1371/journal.pone.0079673

Massaro, D., Nitzburg, G., and Dinzeo, T. (2022). Schizotypy as a predictor for problematic technology use in emerging adults. Curr. Psychol. doi:10.1007/s12144-022-02700-3

Massier, L.A. (2017) (Unpublished results). Computer-mediated communication usage and perceptions amongst young adults with autism spectrum disorder (Doctoral Dissertation). Illinois State University.

Matthews, M., Murnane, E., Snyder, J., Guha, S., Chang, P., Doherty, G., and Gay, G., (2017). The double-edged sword: a mixed methods study of the interplay between bipolar disorder and technology use. Comput. Hum. Behav. 75, 288–300. doi:10.1016/j.chb.2017.05.009

Mazurek, M.O. (2013). Social media use among adults with autism spectrum disorders. Comput. Hum. Behav. 29(4), 1709–1714. doi:10.1016/j.chb.2013.02.004

Mazurek, M.O., Shattuck, P.T., Wagner, M., and Cooper, B.P. (2012). Prevalence and correlates of screen-based media use among youths with autism spectrum disorders. J. Autism Dev. Disord. 42(8), 1757–1767. doi:10.1007/s10803-011-1413-8

Mazurek, M.O., and Wenstrup, C. (2013). Television, video game and social media use among children with ASD and typically developing siblings. J. Autism Dev. Disord. 43(6), 1258–1271. doi:10.1007/s10803-012-1659-9

McCain, J.L., and Campbell, W.K. (2018). Narcissism and social media use: a meta-analytic review. Psychol. Pop. Media Cult. 7(3), 308. http://doi.org/10.1037/ppm0000137

McKinney, B.C., Kelly, L., and Duran, R.L. (2012). Narcissism or openness?: college students' use of Facebook and Twitter. Commun. Res. Rep. 29(2), 108–118. doi:10.1080/08824096.2012.666919

Mehdizadeh, S. (2010). Self-presentation 2.0: narcissism and self-esteem on Facebook. Cyberpsychol. Behav. Soc. Netw. 13(4), 357–364. doi:10.1089=cyber.2009.0257

Meier, E.P., and Gray, J. (2014). Facebook photo activity associated with body image disturbance in adolescent girls. Cyberpsychol. Behav. Soc. Netw. 17(4), 199–206. doi:10.1089/cyber.2013.0305

Millon, T., Millon, C., Davis, R., and Grossman, S. (2009). MCMI-III manual (4th ed.). Minneapolis, MN: Pearson Education, Inc.

Mitchison, D., and Hay, P.J.(2014). The epidemiology of eating disorders: genetic, environmental, and societal factors. Clin. Epidemiol. 6, 89. doi:10.2147/CLEP.S40841

Mittal, V.A., Dean, D.J., and Pelletier, A. (2013). Internet addiction, reality substitution and longitudinal changes in psychotic-like experiences in young adults. Early Interv. Psychiatry 7(3), 261–269. doi:10.1111/j.1751-7893.2012.00390.x

Mittal, V.A., Tessner, K.D., and Walker, E.F. (2007). Elevated social Internet use and schizotypal personality disorder in adolescents. Schizophr. Res. 94(1–3), 50–57. doi:10.1016/j.schres.2007.04.009

Murray, M., Maras, D., and Goldfield, G.S. (2016). Excessive time on social networking sites and disordered eating behaviors among undergraduate students: appearance and weight esteem as mediating pathways. Cyberpsychol. Behav. Soc. Netw. 19(12), 709–715. doi:10.1089/cyber.2016.0384

Nitzan, U., Shoshan, E., Lev-Ran, S., and Fennig, S. (2011). Internet-related psychosis—a sign of the times? Isr. J. Psychiatry Relat. Sci. 48(3), 207.

Noel, J.P., Cascio, C.J., Wallace, M.T., and Park, S. (2017). The spatial self in schizophrenia and autism spectrum disorder. Schizophr. Res. 179, 8–12. doi:10.1016/j.schres.2016.09.021

O'Connor, L.E., Berry, J.W., Lewis, T., Mulherin, K., and Crisostomo, P.S. (2007). Empathy and depression: the moral system on overdrive, in: Farrow, T.E.D., Woodruff, P.W.R. (Eds.), Empathy in Mental Illness. Cambridge University Press, pp. 49–75. doi:10.1111/jopy.12456

Ong, E.Y., Ang, R.P., Ho, J.C., Lim, J.C., Goh, D.H., Lee, C.S., and Chua, A.Y. (2011). Narcissism, extraversion and adolescents' self-presentation on Facebook. Personal. Indiv. Diff. 50(2), 180–185. doi:10.1016/j.paid.2010.09.022

Ooi, J., Michael, J., Lemola, S., Butterfill, S., Siew, C.S., and Walasek, L. (2020). Interpersonal functioning in borderline personality disorder traits: a social media perspective. Sci. Rep. 10(1), 1–8. doi:10.1038/s41598-020-58001-x

Panek, E.T., Nardis, Y., and Konrath, S. (2013). Mirror or Megaphone?: how relationships between narcissism and social networking site use differ on Facebook and Twitter. Comput. Hum. Behav. 29(5), 2004–2012. doi:10.1016/j.chb.2013.04.012

Paulus, F.W., Sander, C.S., Nitze, M., Kramatschek-Pfahler, A.R., Voran, A., and von Gontard, A. (2020). Z. Kinder Jugendpsychiatr Psychother. 48(2), 113–122. doi:10.1024/1422-4917/a000674

Perloff, R.M. (2014). Social media effects on young women's body image concerns: theoretical perspectives and an agenda for research. Gender Roles 71(11), 363–377. doi:10.1007/s11199-014-0384-6

Pettijohn II, T.F., LaPiene, K.E., Pettijohn, T.F., and Horting, A.L. (2012). Relationships between Facebook intensity, friendship contingent self-esteem, and personality in U.S. college students. Cyberpsychology 6(1), article 2. doi:10.5817/CP2012-1-2

Pflüger, L.S., Oberzaucher, E., Katina, S., Holzleitner, I.J., and Grammer, K. (2012). Cues to fertility: perceived attractiveness and facial shape predict reproductive success. Evol. Hum. Behav. 33(6), 708–714. doi:10.1016/j.evolhumbehav.2012.05.005

Phillips, K.A. (1991). Body dysmorphic disorder: the distress of imagined ugliness. Am. J. Psychiatry 148(9), 1138–1149.

Phillips, K.A., McElroy, S.L., Keck, P.E., Pope, H.G., and Hudson, J.I. (1993). Body dysmorphic disorder: 30 cases of imagined ugliness. Am. J. Psychiatry 150, 302–308.

Phillips, K.A., Menard, W., Fay, C., and Weisberg, R. (2005). Demographic characteristics, phenomenology, comorbidity, and family history in 200 individuals with body dysmorphic disorder. Psychosomatics 46(4), 317–325. doi:10.1176/appi.psy.46.4.317

Phillips, K.A., and Diaz, S. (1997). Gender differences in body dysmorphic disorder. J. Nerv. Ment. Dis. 185, 570–577.

Pica, S., Edwards, J., Jackson, H.J., Bell, R.C., Bates, G.W., and Rudd, R.P. (1990). Personality disorders in recent-onset bipolar disorder. Compr. Psychiatry 31(6), 499–510. doi:10.1016/0010-440X(90)90064-Y

Podoll, K., Habermeyer, E., Nöller, B., Ebel, H., and Sass, H. (2000). The internet as a delusional topic in paranoid schizophrenia. Nervenarzt 71(11), 912–914. doi:10.1007/s001150050683

Poon, D.C.H., and Leung, L. (2011). Effects of narcissism, leisure boredom, and gratifications sought on user-generated content among Net-generation users. Int. J. Cyber Behav. Psychol. Learn. 1(3), 1–14. doi:10.4018/ijcbpl.2011070101

Prasad, A., Abhilasha, P., Sivabalan, E., and Manickam, T. (2020). Erotomania coloured by social media usage-a case report. J. Med. Dent. Sci. 9(46), 3495–3496. doi:10.14260/jemds/2020/764

Primack, B.A., Shensa, A., Sidani, J.E., Escobar-Viera, C.G., and Fine, M.J. (2021). Temporal associations between social media use and depression. Am. J. Prev. Med. 60(2), 179–188. doi:10.1016/j.amepre.2020.09.014

Raman, K. (2013). Body dysmorphic disorder: borderline category between neurosis and psychosis. Indian J. Psychiatry 55(4), 380.

Reas, D.L., Whisenhunt, B.L., Netemeyer, R., and Williamson, D.A. (2002). Development of the body checking questionnaire: a self-report measure of body checking behaviors. Int. J. Eat. Disord. 31(3), 324–333. doi:10.1002/eat.10012

Retterstøl, N., and Opjordsmoen, S. (1991). Erotomania–erotic self-reference psychosis in old maids. Psychopathology 24(6), 388–397. doi:10.1159/000284743

Robins, R.W. and John, O.P. (1997). Effects of visual perspective and narcissism on self-perception: is seeing believing? Psychol. Sci. 8(1), 37–42. doi:10.1111/j.1467-9280.1997.tb00541.x

Ronningstam, E. (1996). Pathological narcissism and narcissistic personality disorder in Axis I disorders. Harv. Rev. Psychiatry 3(6), 326–340. doi:10.3109/10673229609017201

Ronningstam, E. and Weinberg, I. (2013). Narcissistic personality disorder: progress in recognition and treatment. Focus 11(2), 167–177. doi:10.1176/appi.focus.11.2.167

Rosen, L.D., Whaling, K., Rab, S., Carrier, L.M., and Cheever, N.A. (2013). Is Facebook creating “iDisorders”? The link between clinical symptoms of psychiatric disorders and technology use, attitudes and anxiety. Comput. Hum. Behav. Rep. 29(3), 1243–1254. doi:10.1016/j.chb.2012.11.012

Ryan, T. and Xenos, S. (2011). Who uses Facebook? An investigation into the relationship between the Big Five, shyness, narcissism, loneliness, and Facebook usage. Comput. Hum. Behav. 27(5), 1658–1664. doi:10.1016/j.chb.2011.02.004

Rydahl, K.F., Brund, R.B., Medici, C.R., Straarup, K.M., Straszek, S.P., and Østergaard, S.D. (2022). Bipolar disorder and regretted behavior in relation to use of social media and online dating. Bipolar Disord. 24(1), 27–38. doi:10.1111/bdi.13169

Santarossa, S., and Woodruff, S.J. (2017). #SocialMedia: exploring the relationship of social networking sites on body image, self-esteem, and eating disorders. Soc. Media Soc. 3(2), 1–10. doi:10.1177/2056305117704407

Sass, L.A., and Parnas, J. (2003). Schizophrenia, consciousness, and the self. Schizophr. Bull. 29(3), 427–444. doi:10.1093/oxfordjournals.schbul.a007017

Sayar, K., and Senkal, Z. (2014). Facebook loves: depression, psychosis and online romance, report of three cases. J. Mood Disord. 4(1). doi:10.5455/jmood.20131230123249

Schmid-Siegel, B., Stompe, T., and Ortwein-Swoboda, G. (2004). Being a webcam. Psychopathology 37(2), 84–85. doi:10.1159/000077584

Schneider, S.C., Mond, J., Turner, C.M., Hudson, J.L. (2019). Gender differences in the presentation of body dysmorphic disorder in a community sample of adolescents. J. Clin. Child Adolesc. Psychol. 48(3), 516–528. doi:10.1080/15374416.2017.1321001

Schwartz, M. (2010) (Unpublished results). The usage of Facebook as it relates to narcissism, self-esteem, and loneliness (Doctoral dissertation). Pace University, New York, NY.

Senín-Calderón, C., Perona-Garcelán, S., and Rodríguez-Testal, J.F. (2020). The dark side of Instagram: predictor model of dysmorphic concerns. Int. J. Clin. Health Psychol. 20(3), 253–261. doi:10.1016/j.ijchp.2020.06.005

Shafran, R., Fairburn, C.G., Robinson, P., and Lask, B. (2004). Body checking and its avoidance in eating disorders. Int. J. Eat. Disord. 35(1), 93–101. doi:10.1002/eat.10228

Shensa, A., Sidani, J.E., Dew, M.A., Escobar-Viera, C.G., and Primack, B.A. (2018). Social media use and depression and anxiety symptoms: a cluster analysis. Am. J. Health Behav. 42(2), 116–128. doi:10.5993/AJHB.42.2.11

Shim, M., Lee, M.J., and Park, S.H. (2008). Photograph use on social network sites among South Korean college students: the role of public and private self-consciousness. Cyberpsychol. Behav. 11(4), 489–493. http://doi.org/10.1089/cpb.2007.0104

Sidani, J.E., Shensa, A., Hoffman, B., Hanmer, J., and Primack, B.A. (2016). The association between social media use and eating concerns among US young adults. J. Acad. Nutr. Diet. 116(9), 1465–1472. doi:10.1016/j.jand.2016.03.021

Simonsen, S., and Simonsen, E. (2011). Comorbidity between narcissistic personality disorder and Axis I diagnoses, in: Campbell, W.K., Miller, J.D. (Eds.), The Handbook of Narcissism and Narcissistic Personality Disorder: Theoretical Approaches, Empirical Findings, and Treatments. John Wiley and Sons, Inc., pp. 239–247. doi:10.1002/9781118093108.ch21

Singh, S., Farley, S.D., and Donahue, J.J. (2018). Grandiosity on display: social media behaviors and dimensions of narcissism. Personal. Indiv. Diff. 134, 308–313. doi:10.1016/j.paid.2018.06.039

Skues, J.L., Williams, B., and Wise, L. (2012). The effects of personality traits, self-esteem, loneliness, and narcissism on Facebook use among university students. Comput. Hum. Behav. 28(6), 2414–2419. doi:10.1016/j.chb.2012.07.012

Solmi, F., Mascarell, M.C., Zammit, S., Kirkbride, J.B., and Lewis, G. (2019). Polygenic risk for schizophrenia, disordered eating behaviours and body mass index in adolescents. Br. J. Psychiatry 215(1), 428–433. doi:10.1192/bjp.2019.39

Sorokowski, P., Sorokowska, A., Frackowiak, T., Karwowski, M., Rusicka, I., and Oleszkiewicz, A. (2016). Gender differences in online selfie posting behaviors predict histrionic personality scores among men but not women. Comput. Hum. Behav. 59, 368–373. doi:10.1016/j.chb.2016.02.033

Stanghellini, G., Castellini, G., Brogna, P., Faravelli, C., and Ricca, V. (2012). Identity and eating disorders (IDEA): a questionnaire evaluating identity and embodiment in eating disorder patients. Psychopathology 45(3), 147–158. doi:10.1159/000330258

Stanghellini, G., Trisolini, F., Castellini, G., Ambrosini, A., Faravelli, C., and Ricca, V. (2015). Is feeling extraneous from one's own body a core vulnerability feature in eating disorders? Psychopathology 48(1), 18–24. doi:10.1159/000364882

Stever, G.S., and Lawson, K. (2013). Twitter as a way for celebrities to communicate with fans: implications for the study of parasocial interaction. N. Am. J. Psychol. 15(2), 339–354.

Stinson, F.S., Dawson, D.A., Goldstein, R.B., Chou, S.P., Huang, B., Smith, S.M., Ruan, W.J., Pulay, A.J., Saha, T.D., Pickering, R.P., and Grant, B.F. (2008). Prevalence, correlates, disability, and comorbidity of DSM-IV narcissistic personality disorder: results from the wave 2 national epidemiologic survey on alcohol and related conditions. J. Clin. Psychiatry 69(7), 1033–1045. doi:10.4088/jcp.v69n0701

Stockdale, L.A., Coyne, S.M., Nelson, D.A., and Erickson, D.H. (2015). Borderline personality disorder features, jealousy, and cyberbullying in adolescence. Personal. Indiv. Diff. 83, 148–153. doi:10.1016/j.paid.2015.04.003

Strauss, J., and Ryan, R.M. (1987). Autonomy disturbances in subtypes of anorexia nervosa. J. Abnorm. Psychol. 96(3), 254–258. doi:10.1037/0021-843X.96.3.254

Stronge, S., Greaves, L.M., Milojev, P., West-Newman, T., Barlow, F.K., and Sibley, C.G. (2015). Facebook is linked to body dissatisfaction: comparing users and non-users. Gender Roles 73(5), 200–213. doi:10.1007/s11199-015-0517-6

Stuart, S., Pfohl, B., Battaglia, M., Bellodi, L., Grove, W., and Cadoret, R. (1998). The cooccurrence of DSM-III-R personality disorders. J. Pers. Disord. 12(4), 302–315. doi:10.1521/pedi.1998.12.4.302

Suzuki, K., Oi, Y., and Inagaki, M. (2021). The relationships among autism spectrum disorder traits, loneliness, and social networking service use in college students. J. Autism Dev. Disord. 51(6), 2047–2056. doi:10.1007/s10803-020-04701-2

Tan, S., Shea, C., and Kopala, L. (1997). Paranoid schizophrenia with delusions regarding the Internet. J. Psychiatry. Neurosci. JPN 22(2), 143.

Tanchotsrinon, P., Maneesri, K., and Campbell, W.K. (2007). Narcissism and romantic attraction: evidence from a collectivistic culture. J. Res. Pers. 41(3), 723–730. doi:10.1016/j.jrp.2006.08.004

Tiggemann, M., and Anderberg, I. (2020). Social media is not real: the effect of 'Instagram vs reality' images on women's social comparison and body image. New Media Soc. 22(12), 2183–2199. doi:10.1177/1461444819888720

Tiggemann, M., and Slater, A. (2014). NetTweens: the internet and body image concerns in preteenage girls. J. Early Adolesc. 34(5), 606–620. doi.org/10.1177/0272431613501083

Tiggemann, M., and Slater, A. (2017). Facebook and body image concern in adolescent girls: a prospective study. Int. J. Eat. Disord. 50(1), 80–83. doi:doi:10.1002/eat.22640

Trull, T.J., Jahng, S., Tomko, R.L., Wood, P.K., and Sher, K.J. (2010). Revised NESARC personality disorder diagnoses: gender, prevalence, and comorbidity with substance dependence disorders. J. Pers. Disord. 24(4), 412. doi:10.1521/pedi.2010.24.4.412

Turner, P.G., and Lefevre, C.E. (2017). Instagram use is linked to increased symptoms of orthorexia nervosa. Eat. Weight. Disord. 22(2), 277–284. doi:10.1007/s40519-017-0364-2

van der Aa, C., Pollmann, M.M., Plaat, A., and van der Gaag, R.J. (2016). Computer-mediated communication in adults with high-functioning autism spectrum disorders and controls. Res. Autism Spectr. Disord. 23, 15–27. doi:10.1016/j.rasd.2015.11.007

Vogels, E., Gelles-Watnick, R., and Massarat, N. (2022). Teens, social media, and technology 2022. Pew Research Center. https://www.pewresearch.org/internet/2022/08/10/teens-social-media-and-technology-2022/. Last accessed May 30, 2022.

Von Rueden, C., Gurven, M., and Kaplan, H. (2011). Why do men seek status? Fitness payoffs to dominance and prestige. Proc. R. Soc. Lond. B Biol. Sci. 278(1715), 2223–2232. doi:10.1098/rspb.2010.2145

Walker, D.C., Anderson, D.A., and Hildebrandt, T. (2009). Body checking behaviors in men. Body image 6(3), 164–170. doi:10.1016/j.bodyim.2009.05.001

Walker, M., Thornton, L., De Choudhury, M., Teevan, J., Bulik, C.M., Levinson, C.A., and Zerwas, S. (2015). Facebook use and disordered eating in college-aged women. J. Adolesc. Health 57(2), 157–163. doi:10.1016/j.jadohealth.2015.04.026

Walters, N.T., and Horton, R. (2015). A diary study of the influence of Facebook use on narcissism among male college students. Comput. Hum. Behav. 52, 326–330. doi:10.1016/j.chb.2015.05.054

Wang, J.L., Jackson, L.A., Zhang, D.J., and Su, Z.Q. (2012). The relationships among the Big Five Personality factors, self-esteem, narcissism, and sensation-seeking to Chinese University students' uses of social networking sites (SNSs). Comput. Hum. Behav. 28(6), 2313–2319. doi:10.1016/j.chb.2012.07.001

Watabe, T., and Suzuki, K. (2015). Internet communication of outpatients with Asperger's disorder or schizophrenia in Japan. Asia Pac. Psychiatry 7(1), 27–35. doi:10.1111/appy.12108

Weiser, E.B. (2015). #Me: narcissism and its facets as predictors of selfie-posting frequency. Personal. Indiv. Diff. 86, 477–481. doi:doi.org/10.1016/j.paid.2015.07.007

Weiss, D.E. (2013) (Unpublished results). The relationship between internet social networking, social anxiety, selfesteem, narcissism, and gender among college students (Doctoral dissertation). Pace University, New York, NY.

Whiting, A., and Williams, D. (2013). Why people use social media: a uses and gratifications approach. Qual. Mark. Res. Int. J. 16(4), 362–369. doi:10.1108/QMR-06-2013-0041

Yamada, M., Kobashi, K., Shigemoto, T., and Ota, T. (1978). On dysmorphobia. Bull. Yamaguchi. Med. Sch. 25(1–2), 47–54.

Yellowlees, R., Dingemans, A.E., Veldhuis, J., and de Vaate, A.B. (2019). Face yourself(ie): investigating selfie-behavior in females with severe eating disorder symptoms. Comput. Hum. Behav. 101, 77–83. doi:10.1016/j.chb.2019.07.018

Yoon, S., Kleinman, M., Mertz, J., and Brannick, M. (2019). Is social network site usage related to depression? A meta-analysis of Facebook–depression relations. J. Affect. Disord. 248, 65–72. doi:10.1016/j.jad.2019.01.026

Zahn, R., Lythe, K.E., Gethin, J.A., Green, S., Deakin, J.F.W., Young, A.H., and Moll, J. (2015). The role of self-blame and worthlessness in the psychopathology of major depressive disorder. J. Affect. Disord. 186, 337–341. doi:10.1016/j.jad.2015.08.001

Zaidens, S.H. (1950). Dermatologic hypochondriasis: a form of schizophrenia. Psychosom. Med. 12, 250–253. https://doi-org/10.1097/00006842-195007000-00006

Zell, A.L., and Moeller, L. (2017). Narcissism and "likes": entitlement/exploitativeness predicts both desire for and dissatisfaction with responses on Facebook. Personal. Indiv. Diff. 110, 70–73. https://doi-org/10.1016/j.paid.2017.01.029

Zimaitis, I., Degutis, M., and Urbonavičius, S. (2020). Social media use and paranoia: factors that matter in online shopping. Sustainability 12(3), 904. doi:10.3390/su12030904

3.7. Supplementary Data

Table 3.10 Evidence that narcissism is associated with higher social media usage

References	Method	Main findings
Bergman et al., 2011	- 361 undergraduate students born in the Millennial generation (mean age = 20.8, 53.6% male) completed a questionnaire on social media usage and the Narcissistic Personality Inventory	- narcissism did not predict amount of time spend on social media, frequency of status updates, posting picture of others, or checking up on social media friends - narcissism predicted the following motivation for using social media: (1) getting as many social media "friends" as possible, (2) wanting social media friends to know what they were doing, (3) believing that their social media "friends" were interested in what they are doing (4) projecting a positive image with their social media profile
Mehdizadeh, 2010	-100 undergraduate students who were Facebook users (50 male, 50 female; mean age = 22.2) had their Facebook page rated by the researcher. Participants were also administered a survey on demographics, Facebook activity, the Rosenberg Self-Esteem Scale, and Narcissism Personality Inventory NPI-16	- higher narcissism predicted number of times FB was checked per day, time spent on FB per session, and greater self-promotion behaviors on the FB photos, status updates, notes, but not self-promotional behaviours on the "About Me" section on FB
Panek et al., 2013	- study one: 486 undergraduate students (74% female, mean age = 18.8) that completed an online survey on social media use and attitudes, and the 16-item Narcissism Personality Inventory (NPI-16) - study two: 93 adults recruited from MTURK (58% female, mean age = 35.2) completed a survey on social media use and the 40-Item Narcissism Personality Inventory	-narcissism predicted FB status updates, daily use of FB, and Twitter posts but not daily Twitter use in the sample of college students - narcissism predicts frequency of FB posting in the adult sample

Poon and Leung, 2011	- snowball sampling of 344 Internet users, aged 13-33 years old (47.4% male, 67.7% female) completed questionnaires on "gratification" reasons for producing online content (ex: needs for recognition, venting negative feelings), short version of the Leisure boredom Scale, Narcissistic Personality Inventory, self-reported levels of online content production	- narcissism predicted greater production of online content on social media sites, blogs, personal webpages, and forums
Skues et al., 2012	- 393 first year undergraduate students (300 women, 93 men, mean age = 20.6) from an Australia university completed the following questionnaires: the Facebook Questionnaire, Australian Personality Inventory, Rosenberg's self-esteem scale, 16-item Narcissistic Personality Inventory, the UCLA Loneliness Scale Version 3	- narcissism was not associated with time spent on FB per day or number of FB friends
Schwartz, 2010	- 218 undergraduate students (86 males, 127 female, 5 unspecified. Mean age = 21) completed questionnaires on FB usage, Rosenberg Self Esteem Scale, Narcissistic Personality Inventory-16, Three-Item Loneliness Scale	- narcissism positively correlated with number of FB friends but not FB usage
Horton et al., 2014	- experiment one: 88 male undergraduate students (mean age = 19.8) assigned randomly to one of three conditions: 1) agentic FB condition (engaging in their own FB profile), 2) communal FB condition (viewing what others have posted on FB), 3) control condition. Participants completed the Narcissistic Personality Inventory, 10-item Rosenberg Self-esteem scale, demographics, and questions on FB use - experiment two: 218 participants recruited from a college and university (141 men, 76 women, mean age = 19.6) engaged in agentic, communal, or control activities on and without a computer	- narcissism positively correlated with self-reported daily FB activity in both experiments

Pettijohn et al., 2012	- 200 undergraduate students (65% female and 35% male, mean age = 19.9) completed the Facebook Intensity Scale, Friendship Contingent Self-Esteem Scale, and Narcissistic Personality Inventory (NPI-16), Ten-Item Personality Inventory	- narcissism positively correlated with number of FB friends but not Facebook intensity
Weiser, 2015	- 1204 participants were recruited from Amazon MTurk (65% female, mean age = 32.8) and completed surveys on social media use and the 40-Item Narcissistic Personality Inventory (NPI-40)	- narcissism predicts greater selfie posting frequency
Walters and Horton, 2015	- 80 male undergraduate students (age range = 18-22) were administered an online survey on FB usage, self-esteem, narcissism, and daily life experiences (filler items).	- narcissism positively associated with FB use
Chen, 2014	-209 young adult Facebook users (71.3% female, 76.6% white, mean age = 19.9 years) completed surveys on their FB usage, Big Five Personality traits, and an adapted Narcissism Personality Inventory	- narcissism positively associated with number of FB friends
Kojouri, 2015	- a sample of 218 adolescents (109 female and 109 male, mean age = 14.6 years) completed an online survey on FB use, the 40- Item Narcissistic Personality Inventory, and psychological well-being	- narcissism positively associated with how long adolescents had held a FB account, number of FB friends, the number of FB group membership, and number of groups that they were the administrator for
Weiss, 2013	- 171 college students aged 18-30 completed a demographic form on their social media usage, Leibowitz Social Scale – Self Report, the Rosenberg Self Esteem Scale, and the Narcissistic Personality Inventory	- narcissism not associated to an individuals' total time spent on their social media site or number of status updates
Ryan and Xenos, 2011	- 1324 adult Australian Internet users between the age of 18 and 44 years old (1158 Facebook users and 166 Facebook non-users) who completed the Big Five Inventory, Narcissistic Personality Inventory (NPI-29), Revised Cheek and Buss Shyness Scale, and Social and Emotional Loneliness Scale for Adults – Short Version. FB users completed Facebook usage questionnaire.	- narcissism and exhibitionism positively associated with preferences for photo and status updates on FB - compared to FB non-users, FB users are more likely to be extraverted, narcissistic, and high in exhibitionism

	- FB users (460 men and 698 women); FB non-users (96 men and 70 women) – mean age group 25-34 for both	
Buffardi and Campbell, 2008	- 129 undergraduate Facebook page owners (100 females, mean age = 19.0) completed a demographic questionnaire, 40-item Narcissistic Personality Inventory (NPI, Raskin and Terry, 1988). - The FB page owners provided their FB page to be rated by 128 undergraduate raters (86 females, mean age = 19.4)	- higher narcissism correlated with greater FB interactions, greater self-promotional content on FB profiles, and attractiveness of the main photo
Arpaci et al., 2018	- convenience sampling used - 179 undergraduate students recruited from a Turkish university (50.28% female, mean age = 20.6) completed online surveys on Narcissistic Personality Inventory 16-Item, Selfie-posting scale, demographics and social media use	- narcissism positively associated with selfie-posting in males but not females
Singh et al., 2018	- 124 social media users (mean age = 34.3, 75% male and 25% female) completed the 13-item Narcissistic personality inventory, social media usage, motivations for social media usage	- narcissistic traits positively associated with greater social media usage, and greater tag/comment/like behaviors on social media sites. - narcissism correlated with greater selfie posting/sending frequency, self-rated selfie attractiveness, greater number of FB friends, FB updates, number of Twitter followers, frequency of tweets
Bibby, 2008	- 174 university students (mean age 20.5) completed questionnaires on social media use, Rosenberg's Self Esteem Scale, an adapted Functional Social Support questionnaire, Narcissistic Personality Inventory, and the Big Five personality traits	- Higher level of exhibitionism-narcissism associated with greater usage of social networking sites for romantic purposes
Hawk et al., 2019	- longitudinal study - 160 girls and 147 boys (mean age = 12.9) completed the Childhood Narcissism Scale, and measures on social rejection, attention seeking, social media disclosure, problematic social media, and smartphone stress in two time intervals February 2015 and February 2016	- earlier adolescent narcissism predicted later social media disclosure, problematic use, and smartphone stress, via increased attention-seeking

Andreassen et al., 2017	- cross sectional convenient sample of 25,532 Norwegians (8, 234 males and 15,298 females; mean age = 35.8 years old) completed the Bergen Social Media Addiction Scale, the Narcissistic Personality Inventory-16, and the Rosenberg Self Esteem Scale	- narcissism was positively associated with addictive social media use
Biolcati and Passini, 2018	- 237 participants (20.7 male and 79.3% female, mean age = 24.0) filled out questionnaires on self-posting behaviors, self-posting motives, 16-item version of the Narcissistic Personality Inventory, the Rosenberg Self-Esteem Scale	- narcissism positively correlated with selfie-posting and importance to likes received on social media
Kircaburun and Griffiths, 2018	- 772 university students (64% female, mean age = 20.7) completed the following questionnaires: Dark Triad Dirty Dozen Scale, Short Sadistic Impulse Scale, Spitefulness Scale, and an adapted version of the Bergen Facebook Addiction Scale.	- Higher narcissism is associated with greater social media usage
McKinney et al., 2012	- 233 undergraduate students (62% women, 38% men, mean age = 19.7) completed questionnaires on openness toward self-disclosure (ex: “I enjoy letting people know things about me”), social media usage, and the Narcissistic Personality Inventory	- higher narcissism associated with greater self-reported number of Facebook friends
Carpenter, 2012	- 294 participants (mean age = 23.3, 68% female) completed questionnaires on demographics, FB use, Grandiose Exhibitionism and Entitlement/Expoitiveness subscales of the Narcissistic Personality Inventory, and the Rosenberg self-esteem scale	- scores on Grandiose Exhibitionism-Narcissism predicted self-promoting Facebook behaviors, Facebook friends count, frequency of accepting strangers as FB friends
Ong et al., 2011	- 275 adolescents with a FB account (165 females, 109 males, one did not report gender, mean age = 14.2) completed the Narcissism Personality Questionnaire for Children-Revised, Extraversion subscale of the NEO Five-Factor Inventory, and Facebook usage	- after controlling for extraversion, narcissism predicted higher self-ratings of their FB profile picture as being more attractive and higher frequency of FB status updates
Wang et al., 2012	- 265 undergraduate students (mean age = 20.2) completed questionnaires on social media use, Big Five Personality Inventory, Rosenberg Self-Esteem, Narcissism Personality Inventory, Sensation Seeking Scale	- narcissism associated with greater likelihood of upload attractive self-photos on social media and more frequent status updates

McCain and Campbell, 2018	- Data from 62 research samples (N = 13,430) are meta-analyzed with respect to the relationships between grandiose and vulnerable narcissism and (a) time spent on social media, (b) frequency of status updates/tweets, (c) number of friends/followers, and (d) frequency of posting selfies on social media	- grandiose narcissism positively related to time spent on social media, frequency of status updates, number of friends/followers, and frequency of selfies posted on social media
Frederick and Zhang, 2019	- 397 Amazon MTurk participants (236 female, 158 male, 3 unknown; mean age = 29.4) completed a demographic survey, a social media usage survey, and the Narcissistic Personality Inventory	- narcissism was not associated with greater social media usage
Alloway et al., 2014	- 410 participants (25 % male, age range 18 – 50 years) completed questionnaires on FB usage, Interpersonal Reactivity Index, and Narcissistic Personality Inventory–16	- higher narcissism scores associated with greater frequency of posting, tagging, and commenting on photos
Zell and Moeller, 2017	- 311 participants (77.4% female, mean age = 26.5) completed an online survey on their FB activity and the Narcissistic Personality Inventory -13	- entitlement/exploitiveness-narcissism correlated with greater importance placed on getting a response on FB, looking popular on FB, and becoming angry and desire at retaliating against people who did not respond to one's status updates - narcissistic Grandiose Exhibitionism correlated with reporting having cared about responses and tried to look popular
Fox and Rooney, 2015	- 800 men (mean age = 29.3) completed the following surveys: Self-Objectification Questionnaire, dark triad traits (narcissism, psychopathy, Machiavellianism), social media usage, posting/editing photo behaviors	- narcissism associated with spending more time on social media - narcissism predicted number of selfies posted, as well as greater photo-editing behaviors in self-photos

Marshall et al., 2020	- study 1: 614 participants (57% female, mean age = 30.6) completed the following questionnaires: Big Five Personality Traits, 13-item version of the Narcissistic Personality Inventory, social media usage, motives for using Twitter - study 2: 503 participants (59% female, mean age = 37.32) completed the Dark Triad questionnaire, social media usage and Berkley Personality Profile	- narcissistic traits positively associated with greater motivation of using Twitter for self-promotional purposes (ex: career promotion, attention seeking, social connections)
Charoensukmongkol, 2016	- 300 university students (39.7% male, 60.3% female) completed questionnaires on selfie-like behaviors (ex: "taking selfies make me happy"), narcissism, attention-seeking, self-centered behavior, loneliness, social media usage, demographics, self-rated friendliness ("I consider myself a sociable person"), and peer pressure ("peers in my group like to show off about being better than others in the group")	- narcissism positively associated with selfie-liking behaviors
Giordano et al., 2019	- 627 undergraduate students (283 males and 344 females, mean age = 22.8) completed a cross-sectional survey on demographics, 40-item Narcissistic Personality Inventory, Smartphone Addiction Inventory-Italian version, selfie-related behaviors (i.e., number of selfies taken in one day, number of selfies posted in one day)	- greater narcissism associated with increased selfie-related behavior (number of selfies taken and number of selfies posted in one day)

Chapter 4. Conclusions

Given the evolutionarily unprecedented and growing popularity of virtual social platforms, understanding how variation in psychological traits is associated with differential patterns of virtual technology usage may reveal key insights into how embodiment instantiates and calibrates shared social realities and social cognitive processes. In line with the main research objectives of this thesis, data from Chapters 1 and 2 indicates that: (1) higher autistic traits in females were associated with increased video game usage, (2) social media usage was generally decreased in autism spectrum disorders, (3) positive schizotypal traits were associated with decreased video game usage, and (4) increased social media usage was associated with psychotic-spectrum condition characterized by self-perturbations, most notably narcissism, body dysmorphia, and eating disorders.

In partial agreement with the Crespi and Badcock (2008) diametrical model, results from Chapter 1 revealed that females, but not males, with higher autistic traits play more video games, and reported male-typical video game genre preferences and motivations. Furthermore, females with higher total autism scores also reported gaming motivations of Fantasy and Customization, but not Social Interaction, and genre preferences for the more male-typical RPG and Customization genres, rather than more typically collaborative genres of Sports/Action/Strategy games. Notably, no statistically significant relationships were detected between autistic scores and video game usage in males. Why might this be? First, given that most video games involve themes of competition (Jansz and Tanis, 2007) and physical violence (Jansz, 2005), and men are more likely to prefer competitive and physically violent themes in video games than women (Hartmann et al., 2015; Hartmann & Klimmt, 2006), higher video game usage among females with higher autistic traits may be indicative of a male-typical cognitive phenotype relative to the general female population. Indeed, one study has found that girls diagnosed with autism endorsed less female-typical non-pretend play behaviours compared to neurotypical girls (e.g., dancing, playing with hair (Knickmeyer et al., 2008), which suggests that females with autism may have less female-typical play behaviours compared to their neurotypical counterparts.

Notably, females with higher total autism scores also reported greater gaming motivations of Stress Relief, Fantasy, and Customization. The reported preference of

playing video games for fantasy but not social interaction purposes suggest that they may offer a unique play environment where “social” fantasy play can be decoupled from in-person social interactions, allowing for the simultaneous experience of partaking in a shared social world while ultimately remaining alone in an atomized state.

Conversely, as predicted by the diametric model, positive schizotypal traits were associated with reduced video game usage in both genders. Scores on the SPQ-Magical Thinking subscale was also associated with slower targeting times, which suggests that decreased video game usage in positive schizotypy may be associated with poorer hand-eye coordination, which may make it difficult to enjoy the gaming experience due to difficulties with controller/console use. Indeed, a positive relationship was detected between SPQ-CogPer and Puzzle games, but Puzzle was not associated with faster reaction or targeting times. Given that most puzzle games tend to be casual (i.e., can be picked up and played at any time) and do not involve high perceptual load of fast-moving targeting, the results described here that lowered video game usage in positive schizotypy may be due to difficulties in dyscontrol in fine motor movements.

Furthermore, findings from Chapter 1 are also consistent with prior research on gender differences in video game usage and preferences, in that males play more video games than females and prefer action-oriented and competitive genres (Lucas and Sherry, 2004). Taken together, results from Chapter 1 suggest that (1) video games may extend real-life play behaviours and preferences, as reflected by gender differences in video game usage and preferences, and (2) patterns of video game usage co-vary with autistic and positive schizotypal traits, in that video game usage is increased in females with higher autistic traits, and it is decreased in positive schizotypy when both genders are pooled together.

What are some clinical implications of the results in Chapter 1? First, unlike “traditional” pretend play where children co-construct a shared fantasy reality together, video games allow for a “pre-made” fantasy world where game rules are relatively predictable, revealed a priori, and all in-person “interaction” can occur in entirely physically atomized context where the player never has to interact with another player face-to-face – all characteristics that may serve as therapeutic mediums for bridging the relatively more stereotyped and solitary play behaviours in autism. Given that most individuals with autism have report social anxiety with in-person social interactions (Spain et al., 2018;

Bejerot et al., 2014), the use of video games to help children with autism in learning pretend play may assist in alleviating some of the interpersonal difficulties that come with navigating non-verbal cues. Indeed, various video games (e.g. Mindlight) have been developed to reduce social anxiety symptoms in individuals with autism spectrum disorders (Malinverni et al. 2017). Taken together, the use of video games in mental health treatments may serve as a useful “scaffold” for helping individuals with autism spectrum conditions in learning to sync themselves to the external social world.

The main results from Chapter 2 revealed that increased social media usage, via its disembodied and isolative nature, may be associated with greater prevalence of psychotic spectrum phenotypes characterized by self-perturbations, particularly narcissism, body dysmorphia, and eating disorders. As discussed previously, humans have evolved reality-testing in shared, physical spaces where there is a “to-and-fro” oscillation of intra- and inter-corporeal affective states where each feeling-state is coupled and co-regulated to one another (Fuchs and De Jaegher, 2009). In this view, the increasing substitution of real-life social interactions with virtual ones may lead to heightened risk of reality-testing failures in individuals predisposed to psychotic-affective traits, particularly if they are already socially isolated in real life. Accordingly, some researchers have speculated that coordinated, embodied social interactions may be important for instantiating a shared reality, and that the construction of a shared social reality may extend beyond the individual organism’s body, allowing for an “extended social mind” that emerges from embodied, iterated interactions (Froese and Fuchs, 2012). In sum, results from our Chapter 2 review suggest that that instantiation of self-other boundaries and reality testing may share common underlying links, via failure or aberrations in intra and inter-corporeal coupling – a direction that future research may explore.

Taken together, the results from Chapter 1 and Chapter 2 provide preliminary evidence on how the disembodied nature of novel technological platforms may augment the expression of socio-cognitive phenotypes in opposite directions along the autism-schizotypy axis. In other words, whereas video games seem to extend the solitary and self-oriented nature of the autistic phenotype by providing a space where fantasy play can occur in an evolutionarily unprecedented atomized and pre-programmed context, the open and performative nature of social media amplifies mentalistic traits (e.g., ideas of reference, social imagination, social surveillance) typical of the psychotic-affective

spectrum. In both cases, video games and social media platforms offer immersive but disembodied environments where individuals interact “together”, but ultimately remain alone. However, whereas video games provide self-contained environments of pre-defined rules, objective goals, and self-centered reward system (e.g. levelling up in World-of-Warcraft hierarchy, obtaining in-game collectibles, moving up levels in Super Mario) – all of which may appeal more to the autistic phenotype, social media platforms tend to be more open, with no clearly defined rules or boundaries, and other-centered rewards (e.g. followers, likes, FB friends), which may appeal to the psychotic-affective phenotype with higher mentalistic traits. In sum, current results point to a preliminary evolutionary psychological framework of how socio-cognitive phenotypes may become more polarized along the mechanistic-mechanistic axis in different virtual reality mediums, with video games amplifying the more self-oriented behaviours of the autistic phenotype and social media expanding other-oriented behaviours of the psychotic-affective phenotype.

Applying an evolutionary framework, specifically analyzing trade-offs in the mechanistic-mentalistic axis, in the investigation of virtual social behaviours may illuminate important insights in how social brain disorders may be mitigated or exacerbated with the increasing adoption of virtual tools in social interactions. For example, clinicians have documented a sudden spike in a functional, psychogenic tic-like syndrome (“Tik Tok tics”) during the COVID-19 pandemic lock-down, which has been linked to social isolation and increased exposure of social media videos on Tourette’s syndrome (Hull and Parnas, 2021; Giedinghagen, 2022). As discussed in length in Chapter 2, physical embodiment may play a key role in shared reality-testing. Given that increased social media exposure may be associated with greater prevalence of psychotic spectrum self-disorders, could social media platforms, in turn, serve as a virtual vector for amplifying or engendering novel social contagion diseases via rapid dissemination of audio-visual information (“viral” memes instead of genes)? Although an in-depth discussion of (virtual) social contagion disorders is beyond the scope of this thesis, researchers have speculated on the existence of a “mass social media-induced illness” (Bartholomew et al., 2012; Müller-Vahl et al., 2022; Fremer et al., 2022). In other words, whereas past epidemics of mass sociogenic illnesses have spread through physical proximity, social media platforms may propagate them more effectively via online networks and videos (Hull and Parnas, 2021). In this light, it may be advisable to limit, rather than to promote,

social media usage in patients who exhibit symptoms of self-aberrations. Furthermore, in-person activities (e.g.: face-to-face exchanges, in-person classes, in-person work) should be prioritized whenever possible as to ensure proper attunement with the external social world.

Following the logic of the Crespi and Badcock (2008) diametrical model, if decreases in attuned embodiment may lead to increased risk of psychotic-spectrum disorders by blurring self-other boundaries, can the opposite (i.e., *increases* in coordinated group body movements) be therapeutic in decreasing overly rigid self-other boundaries in autism (Noel et al., 2017) ? In line with this view, preliminary data indicates that dance movement therapy may improve feelings of well-being, self-other distinction, and social skills in a sample of young adults diagnosed with autism spectrum disorder (Koch et al., 2014). Although the above theoretical framework above remains speculative due to limited empirical data, such connections are, at least, tenable in conjecture and may be worth exploring in future research.

Finally, given the increasing pace of video games and social media platforms replacing in-person social interactions, how else might technology affect the development of the human social brain and their relative pathologies? Results in Chapter 2 observed positive relationships between certain self-disorders and increased social media usage, particularly narcissism, and somatosensory delusions (i.e., body dysmorphia, eating disorders). Altogether, the results suggest that physical embodiment may be an important factor in the substantiation and (social) calibration of self-other boundaries and reality testing. To date, most psychological research has focused on the cultural and sociological explanations for the relationships between social media usage and self-image disorders (Rodgers and Melioli, 2016). In turn, findings from this thesis suggest that an evolutionary psychological framework may be useful in unifying the various seeming disparate somatosensory symptoms in a cohesive structure of basic-self disorders. Although some scholars have speculated on the aetiological relationships between embodiment and psychotic-affective disorders (Fuch, 2009), there has been minimal investigation into applying a nosological framework to analyzing how shared and coordinated physical embodied movement may play a role in self-aberrations.

In conclusion, this thesis contributes to the emerging evolutionary psychiatry framework by being one of the first to investigate how socio-cognitive phenotypes vary and manifest

in virtual realities. To date, there has been minimal investigation on how novel technology may be driving or exacerbate social brain disorders due to evolutionary trait-environment mismatches. In this light, understanding how non-clinical autistic and positive schizotypal traits may manifest in different virtual mediums can uncover new insights in how dissociations in normally embodied and integrated social interactions may affect the expression or development of psychological conditions characterized by self-perturbations. These considerations may motivate new future research directions in using, or not using, virtual techniques in the treatment of psychiatric symptoms and disorders.

4.1. References

Baron-Cohen, S. (2002). The extreme male brain theory of autism. Trends Cogn. Sci., 6(6), 248-254. doi:10.1016/S1364-6613(02)01904-6

Bartholomew, R. E., Wessely, S., and Rubin, G. J. (2012). Mass psychogenic illness and the social network: is it changing the pattern of outbreaks?. J. R. Soc. Med., 105(12), 509-512. doi:10.1258/jrsm.2012.1200

Bejerot, S., Eriksson, J. M., and Mörtberg, E. (2014). Social anxiety in adult autism spectrum disorder. Psychiatry Res., 220(1-2), 705-707. doi:10.1016/j.psychres.2014.08.030

Crespi, B., and Badcock, C. (2008). Psychosis and autism as diametrical disorders of the social brain. Behav. Brain Sci., 31(3), 241-261. doi:10.1017/S0140525X08004214

Fremer, C., Szejko, N., Pisarenko, A., Haas, M., Laudenbach, L., Wegener, C., & Müller-Vahl, K. R. (2022). Mass social media-induced illness presenting with Tourette-like behavior. Front. Psychiatry, 2168. doi:10.3389/fpsyt.2022.963769

Froese, T., and Fuchs, T. (2012). The extended body: a case study in the neurophenomenology of social interaction. Phenomenol. Cogn. Sci., 11(2), 205-235.

Fuchs, T., and De Jaegher, H. (2009). Enactive intersubjectivity: Participatory sense-making and mutual incorporation. Phenomenol. Cogn. Sci., 8(4), 465-486. doi:10.1007/s11097-009-9136-4

Fuchs, T., and Schlimme, J. E. (2009). Embodiment and psychopathology: a phenomenological perspective. Curr. Opin. Psychiatry, 22(6), 570-575. doi: 10.1097/YCO.0b013e3283318e5c

Giedinghagen, A. (2022). The tic in TikTok and (where) all systems go: Mass social media induced illness and Munchausen's by internet as explanatory models for social media associated abnormal illness behavior. Clin. Child Psychol. Psychiatry, doi:10.1177/13591045221098

Hartmann, T., & Klimmt, C. (2006). Gender and computer games: Exploring females' dislikes. J. Comput-mediat. Comm., 11(4), 910-931. https://doi.org/10.1111/j.1083-6101.2006.00301.x

Hartmann, T., Möller, I., & Krause, C. (2015). Factors underlying male and female use of violent video games. , 17(11), 1777-1794. doi.org/10.1177/14614448145330

Hull, M., and Parnes, M. (2021). Tics and TikTok: Functional tics spread through social media. Mov. Disord. Clin. Pract., 8(8), 1248-1252. doi: 10.1002/mdc3.13267

Jansz, J. (2005). The emotional appeal of violent video games for adolescent males. Commun. Theory. 15, 219-241. doi:10.1111/j.1468-2885.2005.tb00334.x

Jansz, J., and Tanis, M. (2007). Appeal of playing online first person shooter games. Cyberpsychol. Behav. 10, 133-136. doi:10.1089/cpb.2006.9981

Knickmeyer, R. C., Wheelwright, S., and Baron-Cohen, S. B. (2008). Sex-typical play: masculinization/defeminization in girls with an autism spectrum condition. J. Autism Dev. Disord., 38(6), 1028-1035. https://doi.org/10.1007/s10803-007-0475-0

Koch, S. C., Mehl, L., Sobanski, E., Sieber, M., and Fuchs, T. (2015). Fixing the mirrors: A feasibility study of the effects of dance movement therapy on young adults with autism spectrum disorder. Autism, 19(3), 338-350. doi:10.1177/1362361314522353

Lucas, K., and Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. Commun. Res., 31(5), 499-523. doi:10.1177/0093650204267930

Malinverni, L., Mora-Guiard, J., Padillo, V., Valero, L., Hervás, A., & Pares, N. (2017). An inclusive design approach for developing video games for children with Autism Spectrum Disorder. Comput. Hum. Behav., 71, 535-549. doi:10.1186/s12888-015-0522-x

Müller-Vahl, K. R., Pisarenko, A., Jakubovski, E., & Fremer, C. (2022). Stop that! It's not Tourette's but a new type of mass sociogenic illness. Brain, 145(2), 476–480. https://doi.org/10.1093/brain/awab316

Noel, J. P., Cascio, C. J., Wallace, M. T., and Park, S. (2017). The spatial self in schizophrenia and autism spectrum disorder. Schizophr. Res., 179, 8-12. doi:10.1016/j.schres.2016.09.021

Rodgers, R. F., and Melioli, T. (2016). The relationship between body image concerns, eating disorders and internet use, part I: A review of empirical support. Adolescent Research Review, 1(2), 95-119. doi:10.1007/s40894-015-0016-6

Spain, D., Sin, J., Linder, K. B., McMahon, J., and Happé, F. (2018). Social anxiety in autism spectrum disorder: A systematic review. Res. Autism Spectr. Disords., 52, 51-68. doi:10.1016/j.rasd.2018.04.007