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"Who Am I" and "How Should I Be": a Systematic Review on Self-Concept and Avatar Identification in Gaming Disorder

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Abstract

Purpose of Review Gaming disorder (GD) appears to be associated with self-concept deficits and increased identification with one's avatar. The goal of this literature review is to highlight study findings assessing psychological and neurobiological correlates of self-concept-related characteristics and avatar identification in GD.

Recent Findings The review was based on three literature researches on GD: (1) self-esteem, (2) emotional, social, and academic self-concept domains and avatar identification, and (3) neurobiological correlates of self-concept and avatar identification. The results indicate that GD is associated with decreased self-esteem as well as deficits in physical, social, and emotional self-concept domains. A relatively stable relationship between higher avatar identification and GD was reported in addicted gamers. Furthermore, addicted gamers showed increased activation of brain regions associated with Theory-of-Mind processing while contemplating their own avatar.

Summary The results point towards impairments in self-concept and increased identification with the virtual gaming character in addicted gamers. This virtual compensation fosters the formation of an idealized self-concept, which grows increasingly distant from their own self-image. Thus, additional empirically based psychological interventions should focus on the development of a realistic self-image by reducing the dysfunctional discrepancy between the ideal self and the real self.

Keywords Gaming disorder · Self-concept · Self-esteem · Avatar · fMRI

Introduction

Since the introduction of gaming disorder (GD) as a tentative clinical condition in the current, fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-5)* [1], the empirical evidence on this condition has steadily grown. In recent years, psychological and neurobiological findings have brought clarity to the debate surrounding the classification of GD. This led to the inclusion of GD as a recognized condition subsumed under the category "Disorders due to substance use or addictive behaviors" in the *International Classification of Diseases* (*ICD-11*) [2].

Besides the relevant focus on the assessment of neural and psychological similarities and differences between substance use disorders, gambling, and GD, certain scientists focused their research aims on the investigation of possible self-concept deficits as one influential factor for the development of GD. One reason for this approach is that particularly adolescents bear a higher risk for GD [3, 4] and adolescence is regarded as the phase in which a healthy self-concept is the main developmental task [5, 6].

Mummendey [7] defines "self-concept" as a subjective description and evaluation of the own character, skills, and capabilities based on experiences and comparisons with representations of an ideal self (i.e., on how one would like to be)

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[7]. The ideal self is the product of social comparisons, which is influenced by family members, peer groups, society, and media. The term "self-concept" was also used synonymously with the concept of global self-esteem described by Rosenberg as the "individual's positive or negative attitude toward the self as a totality" [8]. Ryan and Brown [9] assume that optimal self-esteem and therefore self-concept, respectively, should not originate from seeking esteem. Instead, the self-concept is expected to be fostered by cultivating awareness of one's basic needs for autonomy, competence, and relatedness, as well as by seeking out relationships, vocations, and interests in which those needs can truly be satisfied.

Therefore, the self-concept emerges from a subjective perspective influenced by certain factors (e.g., social environment or convictions from positive and negative learning experiences). Furthermore, self-concept is regarded as a construct involving a physical (e.g., the evaluation of one's own body image), a social (e.g., social competence vs. social anxiety), an emotional (e.g., recognition, expression, and regulation of one's own feelings), and an academic domain (e.g., being disciplined, persistent). It always emerges from cognitive and affective self-evaluation processes that lead to a certain behavior. The main aspects of the emotional self-concept domain are comprised in the model of emotional intelligence of Mayer and Salovey [10]. It postulates the perception, adequate use, understanding, and management of emotions, which mostly occur in the context of relationships, to be the main interrelated abilities for emotional intelligence [10, 11].

Self-Concept and Identification with Virtual Characters in Media and Games

McCall and Simmons [12] already described that media have a significant impact on the development of the self-concept. Media enable an individual to adopt certain roles (e.g., that of a protagonist in a movie) by creating an imaginary idealized picture of oneself, how one would like to be and behave in social situations. These roles can be easily adapted to their own personality traits and therefore become part of the self-concept [12]. Before the Internet witnessed its boom in the 1990s, some researchers assumed that media represented a positive information source that could constantly modify and validate the self-concept [13]. However, in today's world, which is characterized by permanent digital availability, this exclusively positive assumption can no longer be maintained. In particular, in adolescence—during which a person forms the self-concept—an increased confrontation with idealized virtual characters can lead to high discrepancies between the self-image and an ideal self [14]. In combination with low social appreciation, these discrepancies are susceptible to induce feelings of incompetence, anxiety, fear, and depression.

Studies that analyze the content of popular video games found that women in games are typically stylized as idealized sex objects with large breasts and thin hips, while male characters were portrayed as unrealistically muscular [15–17]. Furthermore, Barlett and Harris [18] found that male and female participants displayed significantly lower body self-esteem after playing a video game that emphasized the ideal male or female body, respectively. These findings were independent of the time spent playing video games and body mass index. They might also indicate an increased identification with the avatar in Massively Multiplayer Online Role-Playing Games (MMORPG)[1] players.

In this line, Klimmt, Hefner, and Vorderer [19] assume in their "self-discrepancy hypothesis" that gamers use their avatar to alleviate psychological tension by temporarily reducing the distance between themselves and their ideal self. Indeed, many studies in the literature indicate self-concept deficits and increased identification with one's own avatar have an impact on the development of GD.

Imaging Studies on Self-Concept and Theory of Mind

Functional imaging studies on neural correlates of self-concept or avatar identification use different paradigms that are able to assess different facets of these two constructs.

In most functional imaging studies, the self-concept was assessed by means of self-referential and self-recognition paradigms. During self-referential tasks, participants are asked to evaluate their own personality traits, physical appearance, preferences, or thoughts. Resulting neural activation patterns are then compared with those during the evaluation of a close friend or a famous person [20–22]. Thus, self-referential tasks comprise the conscious cognitive evaluation of the physical, academic, social, and emotional self-concept domains. However, self-recognition paradigms, in which participants see pictures of their face or whole body relative to close friends or a famous person [23], mainly involve evaluating the physical aspect of the self-concept. In a recent meta-analysis, Hu et al. [24] compared neural correlates of self-face recognition and self-referential paradigms. The conjunction analyses revealed that both self-recognition and self-referential processing consistently activate the right anterior cingulate cortex (ACC), the left inferior frontal gyrus (IFG), and left anterior insula [24]. Besides these findings, some studies reported activation in the ventral striatum during self-affirmation tasks, in which a participant is asked to reflect on

[1] MMORPGs are a type of online game displaying specific characteristics which attract a lot of players. In these games, thousands of players inhabit a persistently virtual world. Gamers play alone or in groups, in form of a mostly self-created avatar, which is their virtual graphic agent. Their tasks mainly involve fighting against enemies that are operated by the system (Player vs. Environment, PvE) or against other players (Players vs. Players, PvP). By solving certain tasks or missions (so-called quests) or by killing monsters, the players collect points with which they can obtain new capabilities for their avatar or existing capabilities can be improved. These games possess a very high interactive value due to the team-building activities and can be endless.

personal values, strengths, and attitudes [25–27]. The ventral striatum has often been reported to play a key role in reward anticipation (e.g., gain of money, drug craving) and social learning behavior [25, 28–32]. One explanation for the activity in the ventral striatum during self-affirmation might be the rewarding aspect that individuals strive to maintain a positive view of themselves [25, 27].

Identification with an avatar in a game entails psychological interpersonal skills, such as Theory of Mind (ToM) abilities [33]. ToM is defined as the "the ability to attribute and reason about mental states of others" [34]. Thus, it can be assumed, that the ToM entails the reflection and knowledge about the "affective" and "cognitive" states of another person.

In imaging studies, neural correlates of ToM have been investigated among different paradigms, aiming at individuals making spontaneous assumptions about the mental states of others. One frequently used task is the False-Belief Task, which assesses the ability to recognize that people who do not know a certain detail of the story will make false assumptions about the circumstances of a presented situation, by means of short stories [35].

Available meta-analytical findings indicate that the temporoparietal junction (TPJ), which entails the inferior parietal lobule (IPL) and the angular gyrus (AG); the superior temporal gyrus (STG); the posterior superior temporal sulcus (STS); the precuneus; and the medial prefrontal cortex (MPFC) [36, 37], might be specific neural correlates for ToM processing.

Methods

The following systematic review aims to give an overview of self-report and functional neuroimaging studies on self-concept, as well as avatar identification in GD. Three literature researches were conducted based on the databases Pubmed and PsycINFO. An overview of the steps of the literature research is given in Figs. 1, 2, and 3. Concerning self-esteem the key words [(gaming OR online gaming OR multiplayer) AND (self-esteem OR self-worth)] were searched.

Regarding self-concept we searched for the terms [(gaming OR online gaming OR multiplayer) AND (self-concept OR identity OR identification OR avatar OR social competence OR emotional competence OR body image)].

The corresponding functional magnetic resonance imaging (fMRI) studies were based on the search terms [(avatar OR self-concept) AND (game OR gaming OR multiplayer) AND fMRI].

Studies were screened using the following pre-defined inclusion criteria. Studies had to (i) include the relation between GD and self-concept in self-report or functional imaging studies, (ii) be published in a peer-reviewed journal, and (iii) be available as full text in the English language. No publication time period was specified for the literature search because the number of existing studies in this field of research is relatively small (i.e., most being published between 2007 and 2019).

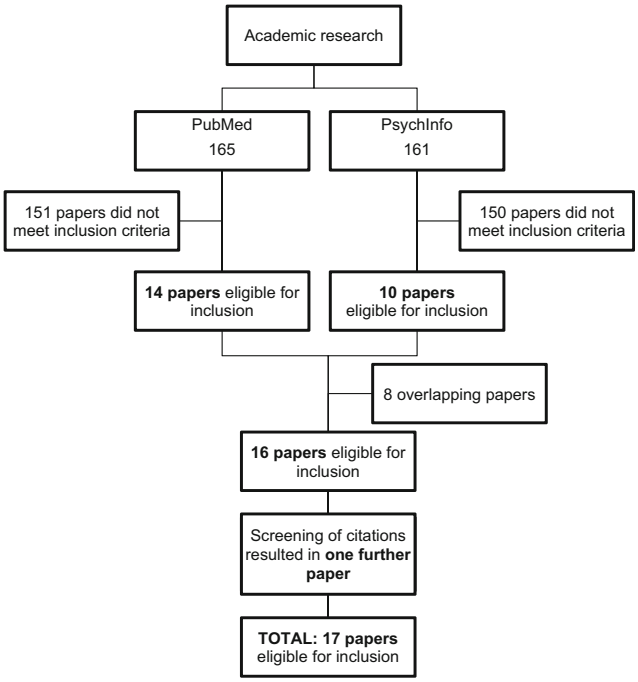

Fig. 1 Literature research for articles concerning psychometric findings on self-esteem. KEYWORDS: [(gaming OR online gaming OR multiplayer) AND (self-esteem OR self-worth)]

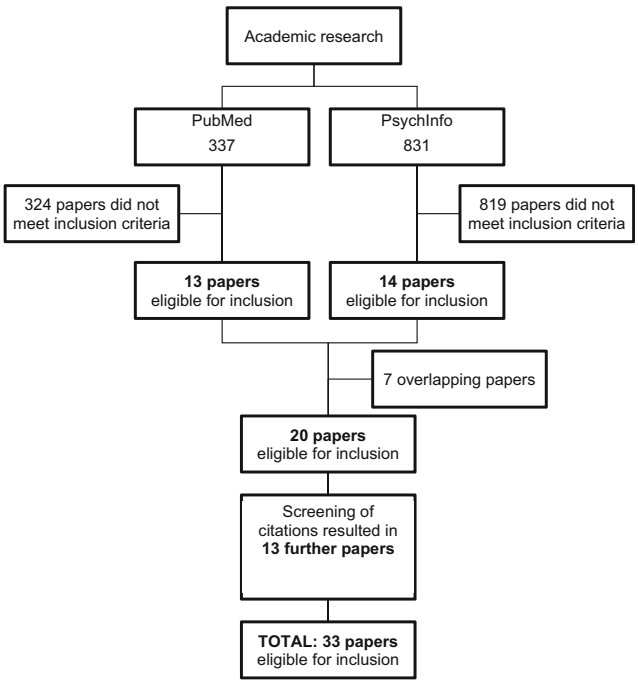

Fig. 2 Literature research for articles concerning psychometric findings on self-concept domains and avatar identification. KEYWORDS: [(gaming OR online gaming OR multiplayer) AND (self-concept OR identity OR identification OR Avatar OR social competence OR emotional competence OR body image)]

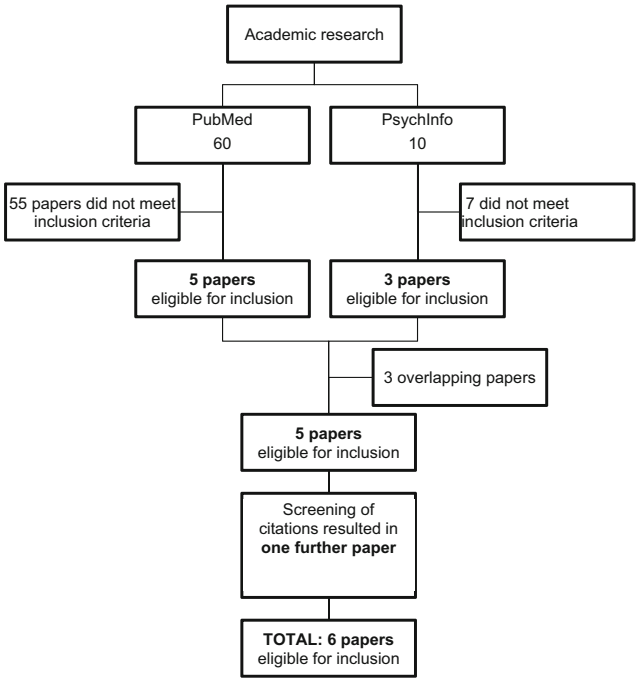

Fig. 3 Literature research for articles concerning fMRI studies on self-concept domains and avatar identification. KEYWORDS: [(gaming OR online gaming OR multiplayer) AND (self-concept OR identity OR identification OR avatar OR social competence OR emotional competence OR body image) AND fMRI]

Besides, all studies were evaluated regarding publication date, study designs, and measurements for GD (coverage of the DSM-5 criteria and psychometric properties according to the reviews of King et al. [38] and King, Haagsma, Delfabbro, Gradisar, and Griffiths [39]).

Results

The final sample of studies consisted of 49 journal articles assessing self-esteem and/or self-concept domains, avatar identification, and neurobiological correlates. Among these, we reviewed 17 findings concerning self-esteem, 33 findings (5 studies overlapped with the studies on self-esteem) that included at least one of the self-concept domains (physical, social, academic, or emotional) or avatar identification, and six neurobiological findings (two of them overlapped with the studies on self-concept domains).

Self-Esteem

As is shown in Table 1, 17 studies assessed self-esteem in participants with GD as well as in normative gamers. According to the recent review of King et al. [38], five studies applied instruments based on DSM-5 criteria for the assessment of GD [48, 57•, 62, 69] and seven studies used tools with relatively high evidential support for their psychometric properties [40••, 57•, 62, 68, 73, 74••]. Seven studies recruited their participants in schools [45, 54, 60, 66, 68, 71, 75•]; seven in game forums or social media forums or via advertisement [40••, 42•, 48, 57•, 62, 69, 77]; two via telephone [73, 74••]; and two in outpatient care [51, 65].

Significant associations between lower self-esteem and GD were found in 15 out of 17 studies [42•, 48, 51, 54, 57•, 60, 62, 65, 66, 68, 69, 71, 73, 74••, 75•]. When taking a closer look at the reported correlation coefficients, the studies find weak and medium-sized correlations, between .12 [48, 57•, 60, 62, 66, 68, 71, 75•] and .43 [69, 74••]. Only two studies did not confirm this association between self-esteem and GD [40••, 45••].

The study research revealed three longitudinal studies of major importance. Wartberg et al. [74••], as well as Lemmens et al. [68], showed in cross-lagged panel design studies on adolescents that a decreased self-esteem at baseline predicted GD scores after 1 year. On the other hand, Baysak et al. [40••] did not confirm this longitudinal predictive relation in adult MMORPG gamers after 2 years. The authors did not observe that changes in GD scores after 2 years were significantly associated with changes in self-esteem.

Self-Concept Domains and Avatar Identification

Our research (Table 2) revealed 33 studies investigating self-concept domains as well as avatar identification in participants with GD as well as in normative gamers. Only two studies applied instruments based on DSM-5 criteria for the assessment of GD with good psychometric properties [57•, 125•] and twelve studies used tools with relatively high evidential support for their psychometric properties [41, 57•, 68, 96, 101, 119, 122, 125•, 135, 143, 145, 148••]. The studies assessing the specific domains of the self-concept, as well as the degree of avatar identification in gaming addicts, mostly used self-rating questionnaires (see Table 2). Four applied instruments asked the participants to evaluate their actual self, their ideal self, and their own avatar in body image as well as in social and emotional competences [65, 77, 116, 129•]. To our knowledge, to date, there are only two studies on adolescents investigating the relationship between academic self-concept (measured by self-evaluation of school performance) and GD [132•, 139•]. Sixteen out of 33 studies recruited their participants in schools [3, 41, 45, 68, 75•, 85, 87••, 103, 109, 116, 132•, 133, 135, 139•, 141, 148••]; eleven in game forums or social media forums or via advertisement [57•, 77, 79, 80••, 90, 125•, 126, 129•, 143, 145, 147]; one via telephone [101]; and five in outpatient care [51, 65, 96, 119, 122].

Physical Self-Concept

Regarding the physical self-concept, our literature research revealed only five studies, four of which reported a negative

Table 1 Self-report studies on self-esteem

Self-report studies on self-esteem

Author (year)	Study type	Sample	Measurements	Main results
Baysak, Yertutanol, Dalgar, and Candansayar (2018) [40••]	Two-year prospective online survey (time between measurements: 2 years)	*Sample size* $N = 110$ ($n = 50$ addicted at t1; $n = 31$ addicted at t2) *Gender* $n = 99$ males $n = 11$ females *Age* $M = 30.75$ years ($SD = 9.68$) *Recruitment* Invitation messages were sent to union leaders and gamers via a Travian Turkish server.	*Measurement of Gaming Disorder*: Game Addiction Scale [41] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurement of self-esteem*: Rosenberg Self-esteem Scale [8]	Changes in GD scores showed no significant association with changes in self-esteem.
Beard, Haas, Wickham, and Stavropoulos (2017) [42]	Cross-sectional online survey	*Sample size* $N = 1044$ *Gender* 63.4% male 35.0% female 1.7% other categories *Age* $M = 30.90$ years ($SD = 9.28$) *Recruitment* Data collection online through Amazon Mechanical Turk.	*Measurement of Gaming Disorder*: Internet gaming disorder test–20 [43] (not covering all DSM-5 criteria) *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [8] Short form of the gaming contingent self-worth scale [44]	Mediation Path Model revealed self-esteem to mediate the effect between age of onset and GD scores. In this regard, global self-esteem was a protective factor for GD for individuals with a later gaming onset. High gaming-related self-worth was linked to low self-esteem.
Colder Carras, van Rooij, van de Mheen, Musci, Xue, and Mendelson (2017) [45]	Cross-sectional study	*Sample size* $N = 12,348$ *Gender* 48.8% males 51.2% females *Age* range from 13 to 16 years $M = 14.1$ years *Recruitment* Study was part of a school-based survey.	*Measurement of Gaming Disorder*: Video Game Addiction Test [46] (not covering all DSM-5 criteria) *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [47]	Gamers with more online social interaction (having a greater than 50% chance of having high online social interaction of some kind) reported fewer problematic gaming symptoms than those with less online social interaction. Latent class revealed six classes for male gamers (normative, problematic, at risk, social at risk extensive, social engaged) and three classes for females (normative, at risk, social engaged). Latent class regression analysis revealed female social engaged gamers had a lower self-esteem compared with normative gamers.
Cudo, Szewczyk, Blachnio, Przepiórka, and Jarzabek-Cudo (2019) [48]		*Sample size* $N = 235$ gamers from 664 screenings *Gender* 37.03% males 62.97% females *Age* range from 18 to 20 years $M = 21.79$ years ($SD = 2.8$) *Recruitment* Electronic questionnaire was sent to Facebook users with the request to share it with friends	*Measurement of Gaming Disorder*: Problem Videogame Playing Questionnaire [49] (covering all DSM-5 criteria) *Measurement of self-esteem*: Polish version [50] of the Rosenberg Self-Esteem Scale [8]	The GD score was negatively correlated with self-esteem. This association was fully mediated by depression.
Hyun et al. (2015) [51]	Cross-sectional study	*Sample size*	*Measurement of Gaming Disorder*: Criteria of Ko et al. [52] and	Independent *t*-test showed significantly lower self-esteem in

Table 1 (continued)

Self-report studies on self-esteem

Author (year)	Study type	Sample	Measurements	Main results
		N = 461 (n = 308 problematic gamers; n = 153 healthy controls) *Gender* n = 414 males n = 47 females *Age* range from 12 to 45 years $M_{problematic}$ = 21.0 (SD = 5.9) years $M_{Healthy}$ = 21.2 (SD = 5.5) *Recruitment* Online Game Clinic Center and advertisements	Internet Addiction Scale (not covering all DSM-5 criteria) score > 50 [53] *Measurement of self-esteem*: Korean modified version of the Rosenberg Self-Esteem Scale [8]	the GD group compared with healthy controls. Upon other predictors, logistic regression analyses revealed a low self-esteem was significantly associated with online gaming addiction.
Jeong et al. (2018) [54]	Cohort study	*Sample size* N = 273 (n = 45 addicted) *Gender* n = 150 males n = 123 females *Age* adolescents from the 3rd, 4th and 7th grades; age not reported *Recruitment* Study was part of the Internet User Cohort for Unbiased Recognition of Gaming Disorder in Early Adolescence (iCURE) study.	*Measurement of Gaming Disorder*: Internet Game Use-Elicited Symptom Screen [55] Internet Gaming Disorder Questionnaire and Interview [56] (covering all DSM-5 criteria) **Measurement of self-esteem:** Rosenberg Self-Esteem Scale [8]	ANOVAs revealed self-esteem to be lower in GD participants (clinically diagnosed by the interview for GD based on DSM-5) than for non-GD participants.
Kircaburun, Griffiths, and Billieux (2019) [57•]	Cross-sectional online survey	*Sample size* N = 242 online gamers (n = 40 addicted) *Gender* n = 224 males n = 18 females *Age* range from 13 to 38 years M = 18.87 (SD = 4.57) *Recruitment* Via several online gaming social media group forums.	*Measurement of Gaming Disorder*: Ten-item Internet Gaming Disorder test [58] (covering all DSM-5 criteria and evidential support for good psychometric properties) *Measurement of self-esteem*: Single item self-esteem scale [59]	Self-esteem showed a significant negative association with GD scores. In a path analysis there was a strong effect of childhood emotional trauma on self-esteem but no indirect effect of self-esteem on GD.
Ko, Yen, Chen, Chen and Yen (2005) [60]	Cross-sectional study	*Sample size* N = 395 *Gender* n = 170 males n = 225 females *Age* range from 13 to 15 years M = 13.8 (SD = 0.7) *Recruitment* At a junior high school in Taiwan.	*Measurement of Gaming Disorder*: Chinese Internet Addiction Scale [61] *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [8]	Multiple regression analysis showed among others lower self-esteem to be significantly associated with higher gaming addiction scores among males, but not females.
Laconi, Pirès, and Chabrol (2017) [62]	Cross-sectional online survey	*Sample size* N = 418 participants *Gender* n = 212 males (51%) n = 206 females (49%) *Age* range from 18 to 30 years M = 21.9 (SD = 3) *Recruitment*	*Measurement of Gaming Disorder*: Internet Gaming Disorder Test-10 [63] (covering all DSM-5 criteria and evidential support for good psychometric properties) *Measurement of self-esteem*: French version of the Rosenberg Self-Esteem Scale [8, 64]	The GD score was significantly negatively associated to self-esteem. Furthermore, the GD group (cut-off ≥5) reported significantly lower self-esteem compared with the non-GD group.

Table 1 (continued)

Self-report studies on self-esteem

Author (year)	Study type	Sample	Measurements	Main results
		via social networking sites, forums and websites dedicated to gaming		
Leménager et al. (2013) [65]	Cross-sectional study	*Sample size* $N = 45$ ($n = 15$ addicted, $n = 15$ non-addicted and $n = 15$ inexperienced players) *Gender* $n = 30$ males $n = 15$ females **Age** $M = 26.33$ ($SD = 4.9$) *Recruitment* Addicted gamers were recruited via outpatient treatment at Central Institute of Mental Health in Mannheim and via advertisement on the internet. Non-addicted gamers were recruited solely via advertisements.	*Measurement of Gaming Disorder*: Ko criteria [52] (not covering all DSM-5 criteria) *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [8]	In contrast to non-addicted and naive participants, addicted gamers (cut-off ≥6) showed lower self-esteem.
Lemmens, Valkenburg, and Gentile (2015) [66]	Cross-sectional online survey	*Sample size* $N = 2444$ adults and adolescents *Gender* $n = 1199$ males $n = 1245$ females *Age* range from 13 to 40 years $M = 24.8$ years ($SD = 8.1$) *Recruitment* By an international market research company	*Measurement of Gaming Disorder*: Internet Gaming Disorder Scales (IGD) [66] 4 questionnaires: a long (27-item) and short (9-item) polytomous scale and a long (27-item) and short (9-item) dichotomous scale. (not covering all DSM-5 criteria but evidential support for good psychometric properties for the 9-item dichotomous scale (IGD-9)). *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [67]	Higher scores on GD scales were associated to lower self-esteem scores. Gamers who fulfilled the criteria for GD showed significantly less self-esteem than gamers without GD.
Lemmens, Valkenburg, and Peter (2011) [68]	Two-wave panel study (time between measurement points: 6 months)	*Sample size* $N = 543$ gamers from 1024 screenings *Gender* 51% males *Age* range from 11 to 17 years $M = 13.9$ ($SD = 1.4$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Game addiction scale [41] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurement of self-esteem*: Rosenberg Self-esteem Scale [67]	Self-esteem was found to be a significant predictor of GD score after 6 months. However, on the other hand, GD score did not predict self-esteem.
Scerri, Anderson, Stavropoulos, and Hu (2019) [69]	Cross-sectional online survey	*Sample size* $N = 149$ adults *Gender* $n = 83$ males $n = 66$ females *Age* range from 18 to 62 years $M = 27.45$ ($SD = 8.49$) *Recruitment* Online via Facebook-networking.	*Measurement of Gaming Disorder*: International Consensus Items to Measure Internet Gaming Disorder [70] (covering all DSM-5 criteria) *Measurement of self-esteem*: Rosenberg Self-Esteem Scale [8].	Self-esteem showed a low negative association with GD score.
Sincek, Tomašić Humer, and Duvnjak (2017) [71]	Cross-sectional study	*Sample size* $N = 1150$ children and adolescents *Gender* $n = 533$ males *Age*	*Measurement of Gaming Disorder*: Problematic Online Gaming Questionnaire [72] (not covering all DSM-5 criteria) *Measurement of self-esteem*:	Gamers playing more than 5 h displayed a lower self-esteem compared with those playing 5 h or less. Self-esteem showed a low but significant negative

Table 1 (continued)

Self-report studies on self-esteem

Author (year)	Study type	Sample	Measurements	Main results
		range from 11 to 21 years $M = 14.77$ ($SD = 2.259$) *Recruitment* At schools.	Rosenberg Self-Esteem Scale [8]	correlation with problematic online gaming. Thus, reporting lower self-esteem was associated with more symptoms of problematic gaming.
Wartberg, Kriston, Kramer, Schwedler, Lincoln, and Kammerl (2017) [73]	Cross-sectional study	*Sample size* 1095 family dyads *Gender* $n = 556$ males $n = 539$ females *Age* adolescents: $M = 12.99$ years ($SD = 0.82$; 12–14 years) at t1 and $M = 13.89$ years ($SD = 0.89$) at t2 parents: $M = 41.63$ years ($SD = 5.76$) at t1 and $M = 42.60$ years ($SD = 5.58$) at t2 *Recruitment* Interviewers of a market research firm conducted the study face-to-face at the families' homes.	*Measurement of Gaming Disorder*: Internet Gaming Disorder Scale [66] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurement of self-esteem*: Subscale 'self-esteem problems' of the German adaptation of the Reynolds Adolescent Adjustment Screening Inventory [165]; Screening psychischer Störungen im Jugendalter-II, SPS-J-II, [166]	Higher self-esteem problems were associated with higher probability of GD (cut-off ≥5) in a logistic regression model. At the same time, self-esteem problems served as a predictor of GD sum score in a linear regression.
Wartberg, Kriston, Zieglmeier, Lincoln, and Kammerl (2019) [74••]	Cross-lagged panel design study (time between measurement points: 1 year)	*Sample size* t1: $N = 1095$ family dyads t2: $N = 985$ family dyads *Gender* $n = 556$ males $n = 539$ females *Age* adolescents: $M = 12.99$ years ($SD = 0.82$) at t1 and $M = 13.89$ years ($SD = 0.89$) at t2 parents: $M = 41.63$ years ($SD = 5.76$) at t1 and $M = 42.60$ years ($SD = 5.58$) at t2 *Recruitment* Interviewers of a market research firm conducted the study face-to-face at the families' homes.	*Measurement of Gaming Disorder*: Internet Gaming Disorder Scale [66] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurement of self-esteem*: Subscale 'self-esteem problems' of the German adaptation of the Reynolds Adolescent Adjustment Screening Inventory [165]; Screening psychischer Störungen im Jugendalter-II, SPS-J-II, [166]	Data shows a low but significant positive association between self-esteem problems and GD scores. Furthermore, GD score at t2 (1 year later) was predicted by self-esteem problems at t1.
You, Kim, and Lee (2017) [75•]	Cross-sectional study	*Sample size* $N = 163$ *Gender* $n = 71$ males $n = 92$ females *Age* range from 14 to 15 *Recruitment* At schools.	*Measurement of Gaming Disorder*: Game Addiction Scale [76] *Measurement of self-esteem*: Self-Esteem Scale [8]	Self-esteem had a significant negative correlation with avatar identification and GD score.

• Study of importance; •• study of major importance

GD gaming disorder

Table 2 Self-report studies on emotional, social, and physical self-concept domains and avatar identification

Author (year)	Study type	Sample	Measurements	Main results
Bessière, Seay, and Kiesler (2007) [77]	Cross-sectional online survey	*Sample size* $N = 51$ *Gender* $n = 43$ males $n = 8$ females *Age* range from 18 to 27 years $M = 21$ years *Recruitment* Invitations to participate via e-mail to a listserv at a local university and to a local gaming group.	*Measurement of Internet Gaming Disorder:* Not assessed *Measurement of self-concept domains:* Big Five Inventory [78]. Ratings modified for evaluating the self the ideal self and the avatar.	*Avatar identification and self-concept related variables* On average, participants evaluated their virtual character as displaying higher conscientiousness, higher extraversion, and less neuroticism than their actual self. The effect was stronger for participants showing higher depressive symptoms or lower self-esteem.
Blinka (2008) [79]	Cross-sectional online survey	*Sample size* $N = 532$ *Gender* 84.6% males 17.6% females *Age* $M = 25$ years *Adolescent players* (under 19 years old): 26.1% *Emerging adults* (20–26 years old): 36.3% *Adults* (27 years and older): 36.8% *Recruitment* Via advertisement.	*Measurement of Internet Gaming Disorder*: Not assessed *Measurement of self-concept domains*: Self-constructed scale measuring avatar identification (12 items)	*Avatar identification* Identification with the avatar was found to be higher in adolescent and emerging adult gamers compared with adults, while emotions, such as shame or pride towards the avatar, did not differ between different age categories.
Burleigh, Stavropoulos, Liew, Adams and Griffiths, 2018 [80••]	Three-wave longitudinal study (time between measurement points: 1 month)	*Sample size* $N = 125$ emerging adults *Gender* $n = 47$ (75.4%) males *Age* range from 18 to 29 years $M = 23.02$ years ($SD = 3.43$) *Recruitment* Via flyers and electronic advertising.	*Measurement of Internet Gaming Disorder*: Short form of the Internet Gaming Disorder Scale [81] (covering all DSM-5 criteria and evidential support for good psychometric properties) *Measurement of avatar identification*: Gamer avatar relationship: Self-Presence Questionnaire [82]	*Avatar identification* Gamer-avatar relationship was a significant predictor for GD after 2 months.
Colder Carras et al. (2017) [45]	Cross-sectional online survey	*Sample size* $N = 12{,}348$ *Gender* 48.8% males 51.2% females *Age* range from 13 to 16 years $M = 14.1$ years *Recruitment* Study was part of a yearly cross-sectional school-based survey.	*Measurement of Internet Gaming Disorder*: Video game Addiction Test [46] (not covering all DSM-5 criteria) *Measurement of self-concept domains*: UCLA Loneliness Scale [83] Social Anxiety Scale Revised [84]	*Social competences* Latent class revealed six classes for male gamers (normative, problematic, at risk, social at risk extensive, social engaged) and three classes for females (normative, at risk, social engaged). Latent class regression analysis revealed only male at-risk gamers but not male problematic gamers showed higher social anxiety and loneliness compared with normative gamers.
Che et al. (2017) [85]	Cross-sectional study	*Sample size* $N = 931$ male participants *Age* range from 13 to 19 years $M = 16.18$ years ($SD = 0.95$) *Recruitment* At schools.	*Measurement of Internet Gaming Disorder:* Modified version of the Revised Chinese Internet Addiction Scale (CIAS) [61]. Sum-score and two subscales: Core Symptoms (14 items) and Related Problems (12 items).	*Emotional self-concept* Scales of emotional intelligence (self-management of emotions, social skills, and empathy) were negatively associated with core symptoms and related problems of GD.

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
			Measurement of self-concept domains: Chinese Emotional Intelligence Scale [86]	Analysis of multiple indirect effects, controlling for the influence of perceived self-efficacy and perceived helplessness: Only self-management had a direct effect on gaming addiction. Perceived self-efficacy mediated the three dimensions of emotional intelligence (i.e., self-management, social skills, and empathy) and online gaming addiction. Moreover, perceived helplessness mediated the relationship between two dimensions of emotional intelligence (i.e., self-management and emotion utilization) and online gaming addiction.
Choo, Gentile, Sim, Li, Khoo, and Liau (2010) [87]	Cross-sectional study	*Sample size* $N = 2998$ *Gender* $n = 2179$ males $n = 819$ females *Age* $M = 11.2$ years ($SD = 2.06$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Measured with a 10-item screening instrument derived from the pathological gambling items of the DSM-IV [88] *Measurement of self-concept domains*: Social competence: Personal Strengths Inventory—II [89]	*Social self-concept* Compared with non-pathological gamers, pathological gamers (cut-off ≥5) showed poorer social competence.
Di Blasi et al. (2019) [90]	Cross-sectional online survey	*Sample size* $N = 390$ *Gender* $n = 289$ males (74.1%) $n = 101$ females (25.9%) *Age* range from 18 to 67 years$M = 28.28$ ($SD = 8.24$) *Recruitment* via advertisements posted on official WoW forums, Facebook groups and pages, and general video game forums	*Measurement of Gaming Disorder*: Italian version [91] of the Internet Addiction Test – WoW Version [92, 93] *Measurement of self-concept domains*: Italian version [94] of the Difficulties in Emotion Regulation Scale [95]	*Emotional self-concept* Emotion dysregulation is significantly associated with GD Score.
Dieter et al. (2017) [96]	Cross-sectional study	*Sample size* $N = 95$ ($n = 30$ addicted) *Gender* $n = 54.74\%$ males $n = 45.26\%$ females *Age* M = 27.15 years ($SD = 8.21$) *Recruitment* Addicted Gamers: at the local day clinic and via advertisements on web pages. Healthy controls: via advertisements on web pages.	*Measurement of Gaming Disorder:* Checklist for the Assessment of Internet and Computer game Addiction (AICA-C) [97] Self-reported scale for addictive online behavior in adults (OSVe; German title: Skala zum Onlinesuchtverhalten bei Erwachsenen) [98] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Questionnaire for Social Anxiety and Social Competence Deficits [99]	*Social and emotional self-concept* Internet gaming addicts (cut-off ≥13 on AICA-C or cut-off ≥13.5 on OSVe) showed lower emotional competences (recognition and expression of own emotions as well as emotional regulation) and deficits in social competences (starting a conversation or processing the information of others) compared with healthy controls. Furthermore, they experienced higher social anxiety (to speak in front of others as well as feelings of social rejection and loneliness) than the healthy control group.

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
			Emotional Competence Questionnaire (German title: Emotionale-Kompetenz-Fragebogen) [100]	
Festl, Scharkow, and Quandt (2012) [101]	Cross-sectional survey	*Sample size* $N = 4500$ gamers from 50,000 screenings *Gender* 58.4% males 41.6% females *Age* range from 14 to 90 $M = 37.8$ *Recruitment* Via telephone survey conducted by a professional market research company.	*Measurement of Gaming Disorder*: Game Addiction Scale (GAS) [41] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Social competence measured by two items adopted from the California Psychological Inventory [102]	*Social self-concept* Social competence and social integration are negatively associated with GAS scores in gamers.
Gaetan, Bréjard, Bonnet (2016) [103]	Cross-sectional survey	*Sample size* $N = 159$ adolescents ($n = 67$ irregular gamers; $n = 92$ regular gamers) *Gender* 52% male 48% female *Age* range from 10 to 18 years $M = 14$ ($SD = 2$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Adolescents were asked to state whether they played video games on a regular or irregular basis *Measurements of self-concept domains*: 10-item Emotion Regulation Questionnaire (ERQ) [104] 40-item Affective Intensity Measure (AIM) [105, 106] 17-item Emotional Expressiveness Scale [107] 40-item Bermond-Vorst Alexithymia Questionnaire (BVAQ) [108]	*Emotional self-concept* Regular gamers displayed higher emotional regulation but also higher emotional intensity and lower expression of their emotions compared with irregular gamers. Alexithymia scores were higher in regular gamers.
Gentile, Choo, Liau, Sim, Li, Fung, and Khoo (2011) [109]	Longitudinal panel study (time between measurement points: 2 years)	*Sample size* $N = 3034$ *Gender* $n = 2179$ males $n = 819$ females *Age* not reported *Recruitment* At schools.	*Measurement of Gaming Disorder*: Measured with a 10-item screening instrument derived from the pathological gambling items of the DSM-IV [88] *Measurements of self-concept domains*: Social competence: Personal Strengths Inventory [89]	*Social self-concept* The group developing pathological gaming after 2 years (cut-off ≥5) showed less social competence compared with those who never fulfilled the criteria for pathological gaming.
Hyun et al. (2015) [51]		*Sample size* $N = 461$ ($n = 308$ problematic gamers; $n = 153$ healthy controls) *Gender* $n = 414$ males $n = 47$ females *Age* range from 12 to 45 years $M_{problematic} = 21.0(5.9)$ years $M_{healthy} = 21.2$ ($SD = 5.5$) *Recruitment* Online Game Clinic Center and advertisements	*Measurement of Gaming Disorder*: Criteria of Ko et al. [52] and Internet Addiction Scale score > 50 [53] (not covering all DSM-5 criteria) *Measurement of social anxiety*: 28-items of the Social avoidance and distress scale (SADS) [110]	*Social self-concept* Independent t-test showed significantly higher social anxiety in the GD group compared with healthy controls. Logistic regression analyses, including demographics, psychopathology, environmental as well as psychological variables, did not reveal a significant association between social anxiety and online gaming addiction.
King, Delfabbro, Zwaans, and Kaptsis (2013) [3]	cross-sectional study	*Sample size* $N = 1287$ *Gender* with pathological technology use: $n = 68$ males $n = 73$ females	*Measurement of Gaming Disorder*: PTU checklist [109, 111] *Measurements of self-concept domains*: Teenage Inventory of Social Skills [112]	*Social self-concept* Adolescents who were classified as pathological video gamers (cut-off ≥5) scored significantly higher on the negative social skills scale compared with

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
		without pathological technology use: $n = 534$ males $n = 539$ females *Age* range from 12 to 18 years $M_{\text{with pathological use}} = 15.2$ ($SD = 1.4$) $M_{\text{without pathological use}} = 14.8$ ($SD = 1.5$) *Recruitment* At schools.		healthy controls. Regarding positive social skills and social anxiety, the gamer group did not differ from healthy controls
Kircaburun et al. (2019) [57•]	Cross-sectional online survey	*Sample size* $N = 242$ online gamers ($n = 40$ addicted) *Gender* $n = 224$ males $n = 18$ females *Age* range from 13 to 38 years $M = 18.87$ ($SD = 4.57$) *Recruitment* online gaming and social media group forums	*Measurement of Gaming Disorder*: Ten-Item Internet Gaming Disorder Test [58]. (covering all DSM-5 criteria and evidential support for good psychometric properties) *Measurements of self-concept domains*: Body Image Dissatisfaction Scale [113]. Social Anxiety Scale for Adolescents [114]. Short form of the UCLA Loneliness scale [115].	*Physical self-concept* Body image dissatisfaction showed no significant correlation with GD scores. Neither was there a significant effect of body image dissatisfaction on GD scores in a path model. *Social competences*: Loneliness and social anxiety were directly significantly associated with GD scores. The significance did not hold when these variables were designated as mediators in a path model including emotional trauma as a predictor for GD scores.
Kwon, Chung, and Lee (2011) [116]	Cross-sectional study	*Sample size* $N = 1136$ *Gender* $n = 692$ males $n = 443$ females *Age* $M = 14.01$ ($SD = 0.51$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Translated and modified version of Young's Internet Addiction Scale [117] (not covering all DSM-5 criteria) *Measurements of self-concept domains*: Discrepancy scores on self-concept related characteristics between real-self ratings and ideal-self ratings were obtained using the method developed by Hoge and McCarthy [118]	*General self-concept* Stepwise multiple regression analysis revealed escape from self, a perceived dysfunctional parent-child relationship as well as a high real-ideal self-discrepancy was one of the strongest predictors of GD.
Leménager et al. (2016) [119]	Cross-sectional study	*Sample size* $N = 57$ ($n = 19$ pathological gamers $n = 19$ pathological social networkers $n = 19$ healthy controls) *Gender* $n = 30$ males $n = 27$ females *Age* $M = 26.05$($SD = 6.26$) *Recruitment* Addicted gamers: via outpatient treatment and via advertisement on the internet. Non-addicted gamers: solely via advertisements.	*Measurement of Internet Gaming Disorder*: Checklist for the Assessment of Internet and Computer game Addiction (AICA-C) [97] Questionnaire for the Assessment of Internet and Computer Game Addiction (OSVe) [120]. (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Body Image Questionnaire (Fragebogen zum Körperbild, FKB-20) [121] Questionnaire for	*Physical self-concept* Pathological [problematic (cut-off ≥7 on OSVe) and addicted (cut-off ≥13 on the AICA or cut-off ≥13.5 on the OSVe)] gamers showed a greater rejection of their body image and rated themselves as less attractive than healthy subjects. *Emotional self-concept* Pathological gamers had increased problems in recognizing, understanding, regulating, and controlling their own emotions, in comparison to healthy controls. They also showed a lower capability to express emotions. *Social self-concept*

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
			Social Anxiety and Social Competence Deficits (SASKO) [99] Emotional Competence Questionnaire (EKF) [100]	Pathological gamers displayed more deficits in the domains of social interaction, social information processing, and loneliness.
Leménager et al. (2014) [122]	Cross-sectional study	*Sample size* $N = 33$ (16 addicted gamers, 17 non-addicted gamers) *Gender* $n = 27$ males $n = 6$ females *Age* addicted: $M = 28.25$ ($SD = 7.72$) non-addicted: $M = 24.94$ ($SD = 4.16$) *Recruitment* Addicted gamers: via outpatient treatment and via advertisement on the internet. Non-addicted gamers: solely via advertisements.	*Measurement of Gaming Disorder*: Checklist for the Assessment of Internet and Computer game Addiction (AICA-C) [97] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of physical self-concept* Body Image Questionnaire [121] Based on photos, participants rated physical attractiveness, gender identity and sympathy of own avatar, self or unfamiliar person on a VAS ranging from 0 to 10.	*Physical self-concept* Addicted gamers (cut-off ≥13) had a higher Body Mass Index (BMI), a more extended negative 'vital body image' and showed a lower gender identity. Bivariate Pearson correlation analyses for the overall sample revealed significant associations between symptom severity (AICA) and BMI, 'vital body image' as well as the degree of gender identity.
Leménager et al. (2013) [65]	Cross-sectional study	*Sample size* $N = 45$ ($n = 15$ addicted, 15 non-addicted and 15 naive inexperienced players) *Gender* $n = 30$ males $n = 15$ females *Age* $M = 26.33$ ($SD = 4.9$) *Recruitment* Addicted gamers were recruited via outpatient treatment at Central Institute of Mental Health in Mannheim and via advertisement on the internet. Non-addicted gamers were recruited solely via advertisements.	*Measurement of Gaming Disorder*: Addiction criteria according to Ko et al. [52] *Measurements of self-concept domains*: Gießen Test [123] for social and emotional domain Body Image Questionnaire [121] Emotional- Competence Questionnaire [100]	*Physical self-concept* In contrast to non-addicted and naive participants, addicted gamers (cut-off ≥6) displayed a negative body image. *Emotional and social self-concept* Compared with non-addicted and naive players, addicted gamers rated themselves as less emotionally and socially competent in the Gießen Test, as well as on the Emotional Competence Questionnaire, than non-addicted and naive players. *Avatar identification* Compared with the other groups, addicted players showed significantly lower discrepancies in social and emotional self-concept-related characteristics between an "ideal self" and avatar ratings, while displaying higher discrepancies between their ideal self and real self.
Lemmens, Valkenburg and Peter (2009) [41]	Cross-sectional paper-and-pencil survey	*Sample size* $N_1 = 352$ adolescent gamers from 644 screenings $N_2 = 369$ adolescent gamers from 573 screenings *Gender* Sample 1: 52% females Sample 2: 51% females *Age* range from 12 to 18 years $M_1 = 14.8$ ($SD = 1.64$) $M_2 = 15.2$ ($SD = 1.35$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Game addiction scale [41] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of underlying self-concept* Social competence: The eight items (measuring relationships/interactions, supportiveness, assertiveness, and ability to self-disclose) were based on earlier instruments [112, 124]	*Social self-concept* Game addiction significantly correlated with lower social competence and loneliness.

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
Lemmens et al. (2011) [68]	Two-wave panel study (time between measure points 6 months)	*Sample size* $N = 851$ adolescents ($n = 543$ gamers) *Gender* 51% males *Age* range from 11 to 17 years $M = 13.9$ ($SD = 1.4$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Game addiction scale [41] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of underlying self-concept* *Social competencies* Scale including four items: (1) "Starting a conversation with a stranger," (2) "Expressing my feelings to someone else," (3) "Introducing myself to someone I have not met before," and (4) "Talking to someone about something I feel ashamed of."	*Social self-concept* Autoregressive structural equation models revealed low social competence to be significant predictors of pathological gaming 6 months later.
Lopez-Fernandez, Williams, and Kuss (2019) [125•]	Cross-sectional online survey	*Sample size* $N = 625$ female gamers ($n = 6$ addicted) *Age* $M = 26.87$ ($SD = 6.9$) *Recruitment* Via online posts on game related online forums.	*Measurement of Gaming Disorder*: Short form of the Internet Gaming Disorder Scale [81] (covering all DSM-5 criteria and evidential support for good psychometric properties) *Measurements of self-concept domains*: Embodied Presence [126] Body Shape Questionnaire-8c [127] Antecedents of Identification [128].	*Physical self-concept* Multiple linear regression Analyses: A negative body image predicted increased scores on the Internet Gaming Disorder Scale. *Avatar identification* Embodied presence (defined as the degree of how connected the respondents feel to their own avatar) and identification with the avatar predicted increased scores on the Internet Gaming Disorder Scale. *Social self-concept* Social phobia was a significant predictor for potential online gaming addiction.
Mancini, Imperato, and Sibilla (2019) [129•]	Cross-sectional online survey	*Sample size* $N = 770$ *Gender* $n = 530$ males *Age* $M = 27.48$ (SD = 9.30) *Recruitment* Via advertisements on websites, forums, and Facebook pages.	*Measurement of Gaming Disorder*: Gaming Addiction Scale [130] *Measurements of idealized and utopian avatar*: Short scale of the Big Five Inventory [131] (assessing actual self, ideal self, and avatar). Idealized avatar: positive discrepancy between avatar and self. Utopian avatar: positive discrepancy between avatar and ideal self) Avatar Identification Subscale [126]	*Avatar identification* Multiple regression and mediation analyses: A higher idealization of the avatar was associated with a higher identification with the avatar. In turn, higher avatar identification was associated with GD score. However, only an idealized avatar (but not a utopian avatar) was directly related to GD in the mediation model (avatar identification as a mediator).
Mößle and Rehbein (2013) [132•]	A 4-year longitudinal study (5 measure time points (t1–t5); range between was 1 year) Analyses were restricted to t4 and t5.	*Sample size* $N = 739$ *Gender* 50.6% males 49.4% females *Age* $M_{t4} = 11.5$ $M_{t5} = 12.5$ *Recruitment* At schools.	*Measurement of Gaming Disorder*: Video Game Addiction Scale CSAS; CSAS-I at t4 and CSAS-II at t5 [133, 134]. Different cut-offs for problematic video game use were used. Besides, a sum score for Problematic Video Game Usage (PVGU) was calculated based on ten overlapping items	*Academic self-concept* Problematic video game users rated their academic abilities more negatively in t4 and t5 than unproblematic video game users. Path model explaining problematic video game: problematic video game usage score at t5 showed a significantly negative association with academic self-concept in t4.

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
			Measurements of academic self-concept: FEESS 3–4 subscales (SIKS) [128] self-rating questionnaire of school performance.	
Müller et al. (2015) [135]	Cross-sectional study	*Sample size* $N = 12{,}938$ *Gender* $n = 6097$ males (47.1%) $n = 6841$ females (52.9%) *Age* $M = 15.8$ ($SD = 0.7$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Scale for the Assessment of Internet and Computer game Addiction—Gaming Module (AICA-S-gaming) [136] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Youth Self-Report (YSR) [137, 138]	*Social self-concept* AICA-S-gaming score was significantly negatively associated with social competence ($r = -.03$)
Rehbein and Baier (2013) [139•]	Five-year longitudinal study including two measure time points	*Sample size* $N_{t1} = 1217$ $N_{t2} = 1070$ *Gender* 45.3% males 54.7% females *Age* $M_{t1} = 9.7$ ($SD = 0.63$) $M_{t2} = 15.0$ ($SD = 0.58$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Video Game Addiction scale (CSAS) [140] *Measurements of self-concept domains*: Academic self-concept: Four-item scale measuring the self-concept of school performance (e.g., "I do well in most school subjects"; "I can easily get good grades without exerting myself"). Social self-concept: social integration and exclusion in class were assessed by counting the number of invitations by classmates and evaluating bullying experiences in the previous 4 weeks.	*Academic self-concept* Self-concept of school performance at t1 did not show a significant correlation with GD at t2.
Rehbein, Kleimann, and Mößle (2010) [133]	Cross-sectional study	*Sample size* $N = 44{,}610$ *Gender* 51.3% males 48.7% females *Age* $M = 15.3$ ($SD = 0.69$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Video Game Dependency Scale (KFN-CSAS-II; self-constructed and validated in this article) *Measurements of self-concept domains*: Self-constructed five-item scale measuring social competence	*Social self-concept* Lower social competence significantly predicted higher scores on the Video Game Dependency Scale.
Seo, Kang, and Chae (2012) [141]	Cross-sectional study	*Sample size* $N = 2199$ adolescents ($n = 252$ high risk gamers) *Gender* $n = 1293$ (58.8%) males $n = 906$ (41.2%) females *Age* $M = 13.37$ ($SD = 2.09$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: 20-item Korean version of the Internet game addiction self-test scale developed by the Korea Agency for Digital Opportunity & Promotion (KADO) [142] Cut-off = 38 for high-risk use *Measurements of self-concept domains*: Emotional self-concept: Korean version of the Intensity and Time Affect Survey assessing positive emotions [138]. 17-item Korean version of the emotional expressiveness scale [102].	*Emotional self-concept* High-risk users (KADO cut-off ≥38) compared with general gamers (KADO range = 20–37) showed lower scores on positive emotions, emotional expression and emotional intelligence. Negative correlations between online game use and positive emotion score.

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
			40-item Emotional Intelligence Questionnaire [140].	
Sioni, Burleson and Bekerian (2017) [143]	Cross-sectional online survey	*Sample size* $N = 394$ *Gender* $n = 50\%$ males *Age* Range from 18 to 77 years $M = 34.3$ ($SD = 11.6$) *Recruitment* Online MMORPG-forums.	*Measurement of Gaming Disorder*: Internet Gaming Disorder Scale [66] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of avatar identification* Player-Avatar Identification Scale (PAI) [144]	*Avatar identification* Avatar identification was strongly related to GD.
Sporcik and Glavak-Tkalic (2018) [145]	Cross-sectional online survey	*Sample size* $N = 509$ gamers from 1089 screenings *Gender* $n = 464$ males (91.2%)$n = 45$ females (8.8%) *Age* range from 18 to 40 years $M = 23.14$ ($SD = 4.66$) *Recruitment* Links to the survey were placed on various online video game forums, Facebook groups and pages.	*Measurement of Gaming Disorder*: Internet Gaming Disorder Scale [66] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Self-Concept Clarity Scale (sense of "Who am I") [146]	*Self-concept clarity* GD scores were negatively associated with self- concept clarity. Furthermore, hierarchical regression analyses revealed self-concept to significantly predicted GD scores.
Smahel, Blinka, and Ledabyl (2008) [147]	Cross-sectional online survey	*Sample size* $N = 548$ Gamers *Gender* $n = 464$ males $n = 84$ females *Age* $M = 25$ years adolescents (12–19 years) = 26.9% young (emerging) adults (20–26 years) = 36.3%, Adults (27 years and older) = 36.8%. *Recruitment* Advertisements were placed on several big MMORPG servers. Moreover, participants were contacted via gaming-related web forums and directly in the games.	*Measurement of Gaming Disorder*: 64-item questionnaire self-created *Measurements of avatar identification*: Based on four questions, an "identification" score was built by the authors (Cronbach alpha = 0.80).	*Avatar identification* 26.3% of players state that their "avatar's skills and abilities are like theirs, but somewhat greater" (53.4% disagree), 17.1% of players agree that their "avatar compensates their own skills and abilities" (62.4% disagree). 14.5% of players rate that "both me and my avatar are the same" (67.7% disagree). 18.4% agreed to the statement that the player possessed the same skills and abilities as his avatar and 62.9% disagreed. Younger gamers showed a higher dependence and a stronger identification (sum score) with the avatar. A significant correlation between the severity of GD and avatar identification was found.
van den Eijnden, Koning, Doornwaard, van Gurp, and Ter Bogt (2018) [148••]	Three-wave longitudinal online survey (time between measurement points: 1 year)	*Sample size* $N = 538$ *Gender* 48.9% males 51.1% females *Age* range from 12 to 15 years $M = 12.90$ ($SD = 0.73$) *Recruitment* At schools.	*Measurement of Gaming Disorder*: Nine dichotomous (1 = no 2 = yes) items from the Internet Gaming Disorder Scale [66] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *Measurements of self-concept domains*: Social self-concept: Harters' Self Perception Profile of Adolescents [149, 150]	*Social self-concept* Adolescents' social competence (ability to establish and retain close friendships), as well as life satisfaction, was negatively correlated with symptoms of GD for all measurement points. In addition, GD symptoms at t1 and t2 had a moderate negative effect on perceived social competence at 1 year later. Only for engaged (not pathological) gaming a positive

Table 2 (continued)

Author (year)	Study type	Sample	Measurements	Main results
				effect on perceived social competence was found.
Van Looy, Courtois, de Vocht, and de Marez (2012) [126]	Cross-sectional online survey	*Sample size* *N* = 544 *Gender* 88% males *Age* *M* = 24.17 (SD = 7.46) *Recruitment* Via online game forums and mailing lists.	*Measurement of Gaming Disorder*: Not assessed *Measurements of identification with the avatar*: Player Identification Scale Gamer Motivations [151] Avatar identification Factors: Similarity identification ("My character is an extension of myself"), Wishful identification ("My character has characteristics that I would like to have"), Embodied presence ("I feel like I am inside my character when playing")	*Avatar identification* Avatar identification is positively associated with the motivational factors: roleplay ("How often do you make up stories and histories for you character?"), customization ("How much time do you spend customizing your character during character creation?"), and escapism ("How often do you play so you can avoid thinking about some of your real-life problems or worries?"). Apart from this, avatar identification was related to identification with the game as well as with the gaming group.
You et al. (2017) [75•]	Cross-sectional study	*Sample size* *N* = 163 *Gender* *n* = 71 males *n* = 92 females *Age* range from 14 to 15 *Recruitment* At schools.	*Measurement of Gaming Disorder*: Game Addiction Scale [76] *Measurements of self-concept domains*: Interpersonal Communication Inventory [152] *Measurement of identification with the avatar*: Avatar Identification Scale [153]	*Social self-concept and avatar identification* Avatar identification showed a positive relation to GD. There was also a negative correlation between social skills and GD. In a path model, high avatar identification and low social skills had a significant effect on GD. Besides, social skills had an indirect effect on GD via avatar identification.

• Study of importance; •• study of major importance

GD gaming disorder

body image, to be related to GD [65, 119, 122, 125•]. In their online survey, Lopez-Fernandez et al. [125•] reported a medium-sized correlation between negative body image in female gamers and GD. Three studies observed that gaming addicts reject their body image to a higher degree as compared with non-addicted participants [65, 119, 122]. However, the study samples, recruited from an outpatient clinic, were quite small. Only one investigation did not confirm these results [57•]. It should be noted that most of the studies assessed body image with different instruments. The online survey study of Kircaburun et al. [57•] assessed the body image by means of the Body Image Dissatisfaction Scale (BIDS), whereas Lopez-Fernandez et al. [125•] examined the body image with the Body Shape Questionnaire [127], in their online survey. Three studies [65, 119, 122] applied the Body Image Questionnaire [121].

Social, Academic, and Emotional Self-Concept

The research revealed 25 studies investigating social, academic, and emotional self-concept domains associated with gaming. The assessment of social and emotional self-concept included the evaluation of social appraisal, social anxiety, the ability to start a conversation or to establish and retain close friendships, one's own general mood as well as emotional intelligence characteristics (emotional self-control, and the ability to recognize and express one's own emotions).

Twenty-three of the 25 studies indicated that GD is associated with negative self-evaluation of the own academic performance [132•, 139•] as well as of social [3, 41, 51, 57•, 65, 68, 75•, 87••, 96, 101, 109, 119, 125•, 133, 135, 148••] and emotional competences [65, 85, 90, 96, 119, 141]. One of the remaining two studies observed that only male at risk gamers

and not problematic gamers displayed higher social anxiety and loneliness compared with normative gamers [45]. The other study did not explicitly assess GD [103] but found that adolescent regular gamers (playing significantly more than irregular gamers) reported a better emotional regulation compared with irregular gamers. At the same time, regular gamers displayed more deficits in emotional expression and higher alexithymia compared with those with less usage.

The study research revealed one cross-sectional and five longitudinal studies of major importance. The study of Che et al. [85] assessed the relation between GD and characteristics related to the emotional self-concept (i.e., emotional intelligence) in 931 male adolescents. They reported a negative association of all emotional intelligence subscales with core symptoms and related problems of GD. However, after controlling for perceived self-efficacy and perceived helplessness, only the subscale self-management of emotions showed a direct negative effect on GD scores.

Lemmens et al. [68] observed that deficits in social competences (e.g., starting a conversation, expressing feelings to someone else, or introducing oneself to a stranger), significantly predicted GD symptoms in adolescents after 6 months. Gentile et al. [109] reported in their longitudinal study that those adolescents who developed GD after 2 years showed less social competence at baseline compared with those who never fulfilled the criteria for GD. On the other hand, the study findings of Van den Eijnden et al. [148••] revealed that GD in male adolescents negatively affects social competences 1 year later. Regarding the two longitudinal studies assessing the academic self-concept in school students, Mößle and Rehbein [132•] observed a significant effect of negative self-reported school performance on GD after 1 year in school children. Rehbein and Baier [139•] did not replicate this effect after a 5-year observation period.

Avatar Identification

The research revealed eight out of ten studies reporting a positive association between avatar identification and GD [65, 75•, 80••, 125•, 126, 129•, 143, 147]. The remaining two articles did not consider GD scores in their analyses [77, 79], but the results indicated a strong avatar identification particularly in young gamers.

Findings of one longitudinal study suggest that a close relationship with the own avatar is a high risk factor for GD scores after 2 months [80••]. You et al. [75•] observed a significant positive correlation between avatar identification and GD in adolescents. Lopez-Fernandez et al. [125•] observed that avatar identification, as well as embodied presence, defined as the degree of how connected the respondents feel to their own avatar, predicted GD in adult female gamers. Mancini et al. [129•] assessed more specifically whether the type of avatar or rather the gamers' identification with the graphical agent, correlated stronger with GD score. They found that an utopian avatar—defined as a positive discrepancy in Big-Five personality scores between avatar and ideal self—did not directly correlate with GD but was moderated by the degree of avatar identification. Only an idealized avatar—defined as a positive discrepancy of scores between avatar and actual self—was directly associated with GD.

Neural Correlates of the Self-Concept and Avatar Identification in GD

This literature research revealed six studies, investigating neural correlates of self-concept and avatar identification in addicted and regular gamers. Three of the studies applied tools with relatively high evidential support for their psychometric properties [119, 122, 154•]. Table 3 gives an overview of the findings.

Three studies focused on the assessment of the self-concept in addicted gamers. Only one study assessed the physical domain by means of a self-recognition task during fMRI in addicted and regular MMORPG-players [122]. In this paradigm, participants were presented with photos of themselves, unknown persons, and their own gaming character. No between-group differences were detected, but within-group differences revealed significant decreased activation in the left IPL (AG) during recognition of the self vs. others in the addicted group.

Kim et al. [155] investigated the self-concept with a self-referential task, asking addicted and non-addicted participants to rate self-concept-related sentences about their real self and their ideal self. Between-group comparisons revealed increased activations in the right inferior parietal lobule (IPL) during self- (vs. ideal) reflection in the addicted gamers.

A recent study on adolescents by Choi et al. [156••] assessed general, physical, and social self-concept related characteristics, by evaluating a self-referential task in addicted and non-addicted adolescent gamers. The task included three conditions: (1) thinking about oneself, (2) thinking about Admiral Sun-shin Yi (a very famous, historic Korean hero), and (3) thinking about the own avatar. Participants had to answer 20 items with yes (I agree) or no (I disagree) while being scanned. A baseline control condition was also applied, in which participants had to respond to true or false sentences (e.g., "the train is faster than the car"). Between-group analyses revealed decreased activations in the right inferior frontal gyrus during self-reflection (vs. baseline) in addicted gamers as compared with the regular gamers.

Five of the six studies assessed neural correlates of avatar identification in addicted and regular gamers [119, 122, 154•, 156••, 157••]. One of them applied a self-recognition task and four investigated the construct by means of a self-referential task. Regarding self-referential studies, three of four findings revealed higher activations in the TPJ during avatar exposure

Table 3 FMRI studies on emotional, social, and physical self-concept domains and avatar identification

Author (year)	Topics	Sample	Measures and fMRI-paradigms	Main results
Choi et al. (2018) [156••]		*Sample size* *N* = 27 (12 addicted gamers, 15 healthy controls) *Gender* *n* = 27 males *Age* Internet-addicted: Range from 11 to 18 years, *M* = 13.83 (*SD* = 2.69); healthy adolescents: Range from 14 to 17 years, *M* = 15.33 (*SD* = 0.98) *Recruitment* Addicted gamers: Recruited in Children's hospital via posted flyers among outpatients (South-Korea). Healthy controls: Students currently enrolled in middle and high school in Seoul	*Measurement of Gaming Disorder*: Korean Version of the Young Internet Addiction Scale (YIAS-K) [167] *fMRI-Paradigm*: Self-referential task based on modified items of the Self Perception Profile for Children [168], the Self-Description Questionnaire I, II [169]. Conditions: real self, others, own avatar, and baseline condition (response to true or false sentences).	*Self-concept* *Non-addicted* > *addicted* (cut-off > 50 on the YIAS-K) *Real self* > *baseline* Right IFG, corpus callosum, and bilateral occipital lobe *Avatar identification* *Addicted gamers* > *non-addicted gamers* *Avatar* > *baseline* Right IFG, MPFC, cerebellum, occipital lobe, temporal pole, left ACC, bilateral postcentral gyrus, and precentral gyrus. Right ACC activation was correlated with symptom severity.
Dieter et al. (2015) [154•]	Avatar identification	*Sample size* *N* = 32 (15 addicted players, 17 non-addicted players) *Gender* *n* = 26 males *n* = 6 females *Age Addicted*: *M* = 28.73 (SD = 7.73) Non-addicted: *M* = 24.94 (*SD* = 4.16) *Recruitment* Addicted gamers: Recruited via outpatient treatment and via online advertisement. Non-addicted gamers: Solely recruited via advertisement.	*Measurement of Gaming Disorder*: Checklist for the Assessment of Internet and Computer Game Addiction (AICA-C) [97] Questionnaire for the Assessment of Internet and Computer Game Addiction (OSVe) [98] (not covering all DSM-criteria but evidential support for good psychometric properties) *fMRI-Paradigm*: Self-referential task based on items of the Gießen Test (GT) [123] Conditions: real self, ideal self, and avatar	*Self-concept Addicted gamers* (cut-off ≥ 13 on the AICA-C or cut-off ≥ 13.5 on the OSVe) > *non-addicted gamers* *Avatar* > *real self* Left IFG and AG. *Avatar* > *ideal self* Left TPJ (left AG superior and inferior parietal lobe, MTG), precuneus, MPFC, IFG, middle FG, and precentral gyrus, bilateral precuneus, posterior cingulum, and cuneus. *Avatar* > *self* + *ideal self* Left AG, middle frontal gyrus, and precuneus *Non-addicted gamers* > *addicted gamers* *Ideal self* > *avatar* During reflection of their ideal self compared to their avatar: bilateral AG. *Real self* + *ideal self* > *avatar* Left AG
Ganesh, van Schie, de Lange, Thompson, and Wigboldus (2011) [157]	Avatar identification	*Sample size* *N* = 43 (*n* = 22 WoW-gamers *n* = 21 non-gaming controls) *Gender* *n* = 22 males *n* = 21 females *Age* Gamers: *M* = 22.77 years (*SD* = 2.71) Non-addicted: *M* = 21.71 years (*SD* = 2.88) *Recruitment* Not reported	*Measurement of Gaming Disorder*: Not assessed *fMRI-Paradigm*: In a self-referential task, participants rated the extent to which traits described avatar, self, a close other person, and a familiar distant other person, using a 5-point Likert scale (1 = "not at all", 5 = "very well")	*Gamers* *Avatar* > *real self and others* left inferior parietal lobe The magnitude of IPL activity was associated with a higher propensity to incorporate external body enhancements (e.g., prosthetics and accessories) into one's bodily identity. *Non-gaming controls* Additional control comparisons ruled out a mere familiarity effect. *Avatar* > *familiar distant other* Right rostral anterior cingulate gyrus
Kim, Jung, Kyeong, Shin, Kim, and Kim (2018) [155]	Self-concept	*Sample size* *N* = 39 (19 individuals with GD, 20 healthy controls) *Gender* *n* = 39 males	*Measurement of Gaming Disorder*: Internet Addiction Test (IAT) [117] (not covering all DSM-5 criteria) *fMRI-Paradigm*:	*Addicted gamers* (cut-off > 50 on the IAT) > *healthy controls* *Real self* > *ideal self* Right IPL

Table 3 (continued)

Author (year)	Topics	Sample	Measures and fMRI-paradigms	Main results
		Age Addicted: *M* = 23.3 (*SD* = 2.4) Healthy controls: *M* = 23.4 (*SD* = 1.2) *Recruitment* Via online advertisement.	Self-referential task Conditions: real self, ideal self Self-discrepancy score: Ideal self–self	
Leménager et al. (2016) [119]	Avatar identification	*Sample size* *N* = 57 (19 pathological, problematic, and addicted gamers; 19 pathological social network users; 19 healthy controls) *Gender* *n* = 30 males *n* = 27 females *Age* Pathological gamers: *M* = 5.68 (*SD* = 6.69) Non-addicted internet users: *M* = 27.68 (*SD* = 7.95) *Recruitment* Addicted gamers: Recruited via outpatient treatment and via online advertisement. Non-addicted gamers: Solely recruited via advertisements.	*Measurement of Gaming Disorder*: Checklist for the Assessment of Internet and Computer Game Addiction (AICA-C) [97] Questionnaire for the Assessment of Internet and Computer Game Addiction (OSVe) [98] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *fMRI-Paradigm*: Self-referential task based on Items of the Giessen-Test (GT) [123] Conditions: self-, ideal self, and avatar	*Pathological gamers* [problematic (cut-off ≥ 7 on OSVe) and addicted (cut-off ≥ 13 on the AICA or cut-off ≥ 13.5 on the OSVe)] > *non-pathological* *Pathological gamers > healthy controls* *Avatar > self* Left IPL and AG, middle occipital lope Correlation between left AG activation during avatar > self and actual symptom severity (AICA-C_30) *Addicted gamers (**n**=12) > healthy controls* Left AG
Leménager et al. (2014) [122]	Physical self--concept and avatar identification	*Sample size* *N* = 33 (16 addicted gamers, 17 non-addicted gamers) *Gender* *n* = 27 males *n* = 6 females *Age* Addicted: *M* = 28.25 (*SD* = 7.72) Non-addicted: M = 24.94 (*SD* = 4.16)	*Measurement of Gaming Disorder*: Checklist for the Assessment of Internet and Computer Game Addiction (AICA-C) [97] (not covering all DSM-5 criteria but evidential support for good psychometric properties) *fMRI-Paradigm*: Self-recognition task: Conditions: Images of self, avatar, and unfamiliar persons	No between-group differences. Correlation between decreased activation in the left AG during avatar vs. real self-recognition and higher gender identity (defined as the extent to which a participant experiences him or herself to be similar to others of the same gender) in the whole sample.

Legend: ACC: anterior cingulum; AG: angular gyrus; IFG: inferior frontal gyrus; IPL: inferior parietal lobe; MPFC: medial prefrontal cortex; MTG: middle temporal gyrus; TPJ: temporoparietal junction; GD: Gaming Disorder; • Study of importance; •• Study of major importance

in participants with GD compared with non-addicted gamers [119, 154•, 156••]. The remaining study did not differentiate between addicted and non-addicted gamers [157] but still found increased activations in the left IPL (AG) during the reflection about the own avatar relative to self, close friends, and distant others in long-term regular MMORPG gamers. The only study investigating avatar identification by means of a self-recognition task in addicted and regular gamers did not find significant between-group differences [122].

Discussion

The aim of the current literature review was to examine the relationship between GD and self-concept, as well as avatar identification. The latter was assessed according to the self-discrepancy hypothesis, which assumes that identification with one's own avatar might be a compensation mechanism for self-concept-related deficits [19]. The research examining self-concept in GD comprised self-esteem as well as various other subdomains of self-concept, such as body image as well as social and emotional competencies. Apart from self-report studies, we also considered fMRI investigations on neural correlates of self-concept and avatar identification in GD.

Almost all of the existing eighteen studies agreed that low self-esteem is associated with GD. These results of GD were also confirmed by longitudinal studies [68, 74••]. Two out of three studies reported that low self-esteem increased the risk for GD after 1 year and after 6 months, respectively. Regarding longer measure time points, one longitudinal study did not confirm a relation between changes in self-esteem and changes in symptom severity of gaming addiction after 2 years

[40••]. However, apart from the long 2-year interval between the two assessments in this study, additional reasons for this failed association could be the following: older age of the study sample; the recruitment took place exclusively on an online gaming server; and the assessment was conducted solely via the Internet. The two longitudinal studies which concluded that GD was predicted by a low self-esteem assessed adolescents in face-to-face interviews only [68, 74••]. These aspects make it clear that a comparison between the study results should be treated with caution.

However, the findings do indicate that low self-esteem influences the development of GD in adolescents after 1 year, which raises the question of whether this also applies to adult participants. To clarify this question, further studies are needed.

Beard et al. [42] reported that a high gaming-contingent self-worth was associated with lower levels of overall self-esteem. This might indicate that an individual increasingly forms virtual self-worth by social and performance-related rewards of a game and this, in turn, might lead to enhanced usage and the development of tolerance (i.e., increasing time or frequency of gaming or spending money in games), as well as GD. Grawe [158] considered the enhancement of self-esteem as a basic human need. According to the study findings, this need seems to be violated in persons with GD and might have an influence on the development of GD after 1 year. Conclusively, it can be said that therapeutic approaches regarding GD should take the enhancement of self-esteem into account.

The literature research did not reveal many studies assessing the physical self-concept in GD. Four out of five studies reported deficits in body image to be associated with GD [65, 119, 122, 125•]. It should, however, be noted that three studies were based on very small sample sizes (65, 119, 122; $n_{\text{addicted gamers}} < 20$) and one other study assessed female gamers only [125•]. One online survey did not confirm this relationship [57•]. As mentioned above, all studies assessed body image with different instruments which raises the question of how comparable and valid the results are. In conclusion, the data indicate a relationship between a negative body image and GD; however, this domain of self-concept and its influence on GD need to be further assessed and replicated for valid results.

Most studies on the emotional self-concept revealed that addicted gamers rated themselves as having more difficulties in emotional intelligence, such as recognizing and expressing own emotions as well as in emotional regulation [65, 85, 90, 96, 119, 141]. However, one study showed that gamers with higher usage showed improved emotional regulation but displayed more deficits in emotional expression and higher alexithymia as compared with those with less usage [103]. The authors concluded that gamers might improve their emotional functionality by learning coping strategies that help them to deal with problematic emotional situations. They can accomplish this with their avatar in a virtual environment, which, in turn, can then be applied to real-life situations. This could, particularly, be the case for regular but not for problematic or addicted gamers, who escape from negative feelings that arise from intra- and interpersonal problems in everyday life more and more. They increasingly fuse with the virtual world and use the game as a sort of new virtual life. Thus, it can be hypothesized that deficits in emotional competencies are associated with GD but maybe not with regular gaming. One explanation might be that addicted gamers initially have the same motives for gaming (i.e., dealing with negative emotional and social situations in a better way). However, addicted gamers might have higher psychopathology for depressive and (social) anxiety symptoms leading to social withdrawal and this, in turn, inhibits them to transfer their learned strategies into real life. Villani et al. [159] suggested this assumption in a recent review. They analyzed studies assessing the relationship between videogame playing and changes in emotional regulation abilities. Their findings revealed a curvilinear course of the relationship between gaming and mental health outcomes (i.e., moderate players demonstrated better psychosocial and mental health). They concluded that playing video games may enhance emotional intelligence and emotional regulation for regular but not for excessive problematic gamers.

According to the findings considered in our review, it can be concluded that addicted gamers have stronger deficits in emotional processing and emotional regulation compared with non-addicted gamers or non-gamers. In order to create a stable foundation for learning how to channel strong emotions in a healthy and mindful way, individuals with impaired emotional competencies need even more social attention, social support, and promotion in line with their skills and ambitions. This assumption is in accordance with related findings showing that socialization mediates between emotional competencies and the development of GD [155, 160]. Kim et al. [155] found that aggressiveness was associated with a risk of GD and this relationship was mediated by a dysfunctional and negative father-child communication style. Also, Zhang et al. [160] reported less social support to be negatively correlated with GD. Less social support might also be a result of certain difficult personality traits, such as high impulsivity or strongly introverted behavior. The former of which might lead to interpersonal conflicts, whereas the latter might hinder finding social contacts. The way the environment (e.g., family and teachers) deals with these character traits is paramount for the formation of a healthy self-concept.

Negative social feedback or exaggerated societal or familial expectations placed upon the individual, inevitably lead to higher discrepancies between the ideal self ("How should I be?") and the real self ("Who am I?"). This, in turn, increases the risk of deficits in emotional and social competencies as well as depressive and anxiety symptoms.

Almost all studies on the social domain of the self-concept reported addicted gamers to rate themselves as

more lonely and anxious to speak in front of others or to be at the center of social attention, as well as having problems with starting a conversation with a stranger [3, 41, 51, 57•, 65, 68, 75•, 87••, 96, 101, 109, 119, 125•, 133, 148••]. Apart from that, three longitudinal studies showed that deficits in social competencies were a cause (after 6 months and 2 years) as well as a predictor for GD after 1year [68, 109, 148••].

These results might give a hint that in the short term online games may effectively reduce the discrepancy between the ideal self and the real self, by enabling anonymous communication and the formation of virtual friendships as well as by conveying the feeling to be an important part of a gaming group. In the long run, however, coping with negative emotions (e.g., feelings of insufficiency) and social problems through gaming increases the risk to develop GD. The augmented escapism into a virtual world, in turn, leads to increased social withdrawal in the real world and less learning experiences in social and emotional situations. In due course, the gamer might build a virtual self-concept that is closer to the ideal self, which could make it difficult to accept the real self. This idealized virtual self-concept is acted out through the gamer's avatar.

Accordingly, study findings on avatar identification indicate that the own avatar (and its in-game skills) compensates for self-concept deficits [65, 80••, 125•, 129•, 143, 147]. You et al. [75•] suggested self-esteem to have a significant negative correlation with avatar identification and GD. Furthermore, avatar identification mediated the relationship between GD and depression, as well as social skill deficits.

Additionally, Mancini et al. [129•] reported that solely the use of an idealized avatar (rated to be better than the real self and worse than the ideal self) is directly related to GD, as compared with using a utopian avatar (rated as being better than the ideal self). This result indicates that gamers tend to create idealized avatars, which still partly resemble their real selves.

The second aim of the review was to highlight the studies investigating neural correlates of self-concept and avatar identification in addicted gamers. The literature research revealed six studies assessing these features with self-referential and self-recognition tasks (Table 2).

Only three functional imaging studies were found, assessing underlying self-concept-related characteristics of the brain between addicted and non-addicted gamers. One of them applied a self-recognition task and did not detect any between-group differences [122]. The remaining two studies assessed underlying neural mechanisms of the self-concept in GD with self-referential tasks. However, the study findings were based on different contrasts. Choi et al. [156••] reported decreased activation in the right IFG in addicted gamers during self-reflection in contrast to a baseline condition of neutral sentences. Kim et al. [155], on the other hand, observed increased activation in the IPL during self- vs. ideal self-reflection in the addicted group. The meta-analysis of Hu et al. [24] reports that both regions are associated with self-referential processing.

Together with the angular gyrus, the IPL is a relevant part of the TPJ, which is said to be associated with ToM processing (i.e., the ability to put oneself in another person's cognitive mindset and to make assumptions about other persons' cognitive processes and intensions) [36, 37]. However, as mentioned above, the IPL and other ToM-associated regions, such as precuneus and the superior temporal gyrus, were also reported in the meta-analysis on self-referential processing by Hu et al. [24].

The IPL and the IFG are considered to be the main components of the mirror neuron network [161, 162]. They form the neural basis for observational learning [163] and fire in the same way during one's own actions and while observing someone else act. Therefore, it is not too far of a stretch to argue that ToM processing—or the identification with others—plays a relevant role during self-reflection during which an individual must retrieve knowledge about their own "affective" and "cognitive" character traits vis-à-vis previous experiences. Choi et al. [156••] assessed the correlates of self-concept in GD based on the task contrast between self-reflection and a baseline condition, which showed a decrease in IFG activation in addicted gamers as compared with non-addicted gamers. This could mean that addicted gamers may have more difficulties retrieving information regarding their self-concept. On the other hand, Kim et al. [155] found an increase in IPL activation in the addicted group during self vs. ideal self-reflection. This could be the result of a closer relationship and, therefore, an increased identification with the real self, as compared with the ideal self in individuals with GD.

Three out of five fMRI studies on avatar identification (Table 2) also observed increased activation in TPJ regions, such as the IPL (e.g. AG) and the temporal pole, during avatar reflection (as compared with reflection of the real self and ideal self as well as a baseline condition) [119, 154•, 156••]. Together with the results of Kim et al. [155] on self-reflection, the neural findings might demonstrate that addicted gamers identify to a higher degree with their avatar as compared with their real self and their ideal self. However, they still might have a closer relationship to their real self as compared with their ideal self (avatar > real self > ideal self). This assumption is in accordance with the self-report findings indicating avatar identification as a predictor of GD [75•, 125•, 129•].

However, the studies included in this review present some limitations. First, most of the studies are based on cross-sectional designs. More longitudinal studies are needed to explore causal links between self-esteem, self-concept as well as avatar identification and GD. Second, male participants are often in the majority which impairs generalizability on both genders. Third, different studies used different instruments to measure the mentioned variables, which makes the results less comparable. Fourth, all neurobiological findings were based

on small sample sizes ($n < 20$ for the control group and $n < 20$ for the group of addicted or pathological gamers). Fifth, only few studies applied instruments covering all DSM-5 criteria [38].

Conclusions

In sum, the current review provides the following conclusions. First, there seems to be a stable association between GD and low self-esteem, as highlighted in the majority of existing studies on this topic. Second, the specific domains of self-concept seem to be associated with GD. At closer examination, it becomes apparent that the social and emotional self-concept domains show negative relations to GD. The relationship of the academic as well as the physical self-concept appears to be less stable and warrants further research. Third, the self-report findings are mirrored in the neurobiological studies on self-concept and avatar identification.

Thus, the self-report and neurobiological findings indicate that deficits in self-concept might be compensated with a virtual idealized avatar. This is also in accordance with the "Interaction of Person-Affect-Cognition-Execution" (I-PACE) model of Internet use [164]. The authors suggest that with repeated use, initial gratification (positive reinforcement) of the specific application decreases and the compensation for negative feelings (e.g., loneliness) and cognitions (e.g., "I am nobody without the Internet") becomes increasingly important.

The escapism of the virtual gaming world; the feeling of belonging to an important group; the formation of virtual friendships; and the identification with a mostly idealized avatar might be a fast and reward-related strategy to compensate for a negative self-concept. The positive effect that gaming has by relieving gamers from negative mood states for a short period increases the probability of repeat gaming and, therefore, the risk to develop GD. The individual increasingly fuses with the virtual world and accordingly fosters an idealized virtual self-concept that grows ever more distant from their own self-image.

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- • Of importance
- •• Of major importance

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