

Self-Determination Theory in HCI Games Research: Current Uses and Open Questions

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ABSTRACT

Self-Determination Theory (SDT), a major psychological theory of human motivation, has become increasingly popular in Human-Computer Interaction (HCI) research on games and play. However, it remains unclear how SDT has advanced HCI games research, or how HCI games scholars engage with the theory. We reviewed 110 CHI and CHI PLAY papers that cited SDT to gain a better understanding of the ways the theory has contributed to HCI games research. We find that SDT, and in particular, the concepts of need satisfaction and intrinsic motivation, have been widely applied to analyse the player experience and inform game design. Despite the popularity of SDT-based measures, however, prominent core concepts and mini-theories are rarely considered explicitly, and few papers engage with SDT beyond descriptive accounts. We highlight conceptual gaps at the intersection of SDT and HCI games research, and identify opportunities for SDT propositions, concepts, and measures to more productively inform future work.

Author Keywords

Games; Gamification; Motivation; Play; Player Experience; Self-Determination Theory; Theory

CCS Concepts

•Human-centered computing → HCI theory, concepts and models; Empirical studies in HCI; •Applied computing → Computer games;

INTRODUCTION

One aim of games and play research in Human-Computer Interaction (HCI) – hereafter abbreviated to HCI games research – is to understand what constitutes engaging player-computer interaction [117]. These insights may in turn be applied to design more appealing games and playful interactions, evaluate qualities of the player experience, and create interactive systems that motivate people to engage with purposes beyond entertainment (e.g., serious games, gamification). Theories and

concepts from motivational psychology have proven particularly popular with HCI scholars to describe and analyse games [30, 99]. The notion of *flow* [128], for instance, has been influential in studying the player experience [79, 124, 177] and modelling optimally challenging games [40, 113]. Another theory that has proven influential is Self-Determination Theory (SDT), a major psychological theory of human motivation [48, 163] that has been successfully applied to study motivational processes in a variety of domains and contexts (e.g., academic, work, relationships). SDT has been used to study the motivational appeal of games [160, 166], inform gameful design [60, 149, 187], analyse the player experience [93, 150], and applied within the games industry for evaluation and testing [7, 85, 189]. In fact, the original papers on SDT and games by Ryan, Rigby and Przybylski [144, 166] have been cited over 3000 times on Google Scholar.

While these numbers attest to the popularity of (citing) SDT in games research, they say little about *how* SDT has contributed to HCI games research, nor the ways in which HCI games scholars have applied and engaged with the theory. Some of the purported benefits of applying (psychological) theories to HCI include establishing a common understanding and terminology around specific phenomena, formulating predictions concerning these phenomena under common and novel circumstances, as well as generating original hypotheses and design implications [13, 132, 153]. However, the extent to which SDT has informed HCI games research remains unclear. Concerns have also been raised around the misrepresentation of external literature in exertion games research [120], and with respect to SDT in gamification research [116, 169]. Not only does this risk the proliferation of misunderstandings and lack of clarity regarding SDT-based concepts – it may also give rise to invalid research findings around the motivational appeal of games, ineffective design implications, or even negative effects on player wellbeing.

Following endeavours on the use of theory in HCI [38, 121, 153, 195], we present findings from a systematic literature review encompassing 110 CHI and CHI PLAY papers that cite SDT in the context of games, play, and game-adjacent systems. We take stock of how and why SDT and its various concepts (e.g., intrinsic motivation, need satisfaction) have been applied to HCI games research. Our contribution is threefold: first, we find that SDT, particularly the concepts of competence need satisfaction and intrinsic motivation, have been widely applied to analyse the player experience, inform game design, and model player-computer interaction. However, despite this

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popularity, certain core concepts and mini-theories, such as relatedness or organismic integration, have received little to no attention. Second, while many works resort to SDT-based questionnaires to analyse the player experience, few papers engage with SDT beyond merely descriptive accounts. Third, based on our analysis, we highlight conceptual gaps at the intersection of SDT and HCI games research, and identify opportunities for SDT propositions, concepts, and measures to more productively inform future work.

SELF-DETERMINATION THEORY

SDT is a psychological macro-theory of human motivation, growth, and wellbeing [47, 48, 163] that characterises humans as fundamentally active organisms. In particular, SDT posits *intrinsic motivation*, an innate human propensity for activities perceived as interesting and enjoyable, and *organismic integration*, which directs the assimilation and organisation of external stimuli into the developing self. Individuals are considered to “thrive” and experience wellbeing to the extent that their actions reflect the truest values of the self [156]. Motivation, internalisation, and wellbeing processes are energised by the satisfaction of three basic psychological needs – autonomy, competence, and relatedness (discussed further below).

At its core, SDT is a *scientific* theory [163], in that it contains a number of empirically-testable propositions [199] that generalise across varied contexts, which serve to explain and predict the impact of certain events on motivation and wellbeing. Moreover, Ryan and Deci have described SDT as *practical*, “as it points to how features of contexts [...] facilitate or undermine motivation” [164, p. 4], as well as *critical*, “as it examines proximal social contexts [...] as well as more pervasive cultural, political, and economic conditions in terms of their adequacy in supporting versus impairing human thriving” [164, p. 4].

SDT is broadly organised into six mini-theories, whose underlying concepts are continuously developed, critiqued, and revised (e.g., [186, 190, 191]). In the following, we briefly describe the key tenets and mini-theories of SDT, according to their frequency of use in the reviewed CHI and CHI PLAY literature. Moreover, we highlight key findings from SDT-based games research. A comprehensive description of SDT is beyond the scope of this paper, but we refer readers to [163, 187] for more detail.

Need Satisfaction

Basic psychological needs theory (BPNT) posits three basic psychological needs that energise organismic processes: *competence*, the feeling of having an effect; *autonomy*, a sense that actions are self-endorsed and performed willingly; and *relatedness*, a sense of reciprocal care, value, and belonging in relation to other social figures and collectives [158]. *Satisfaction* of these needs promotes intrinsic motivation, internalisation, and wellbeing (see also Figure 1).

Several conceptual and empirical developments have emerged within SDT around psychological needs. *Need frustration*, for instance, denotes the active thwarting of basic needs – feeling incapable, controlled, or ostracised by others [163]. Although empirical studies of need frustration began only recently [12,

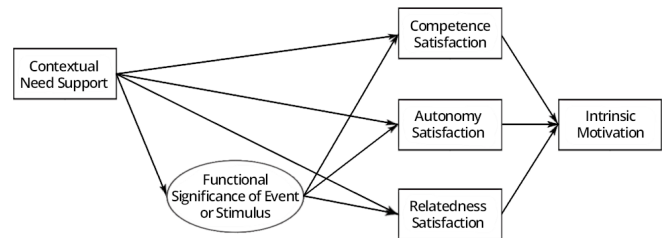


Figure 1. The key tenets of Cognitive Evaluation Theory (CET): the extent to which a stimulus influences experienced need satisfaction and intrinsic motivation is determined by the social context and its functional significance.

173], need frustration has been shown to predict negative psychosocial outcomes (e.g., burnout, stress) more effectively than need satisfaction [71, 76]. Other considerations [171, 172] differentiate need satisfaction as a *motive* for behaviour (i.e., pursuing an activity in the hopes of having one’s needs for autonomy, competence, and relatedness satisfied) versus an *experiential requirement* (i.e., experiencing the feeling of autonomy, competence, and relatedness with valued others). In the context of videogame play, need satisfaction has repeatedly been found to predict game enjoyment [135, 166] and playing persistence [129], with fewer studies having investigated experiences of need frustration [3, 143, 184].

Need satisfaction during play is commonly indexed by the Player Experience of Need Satisfaction (PENS) scale, which comprises five subscales: competence, autonomy, relatedness, presence/immersion, and intuitive controls. The PENS was developed as part of the first SDT research into games [166]; the authors’ subsequent work also implies their (unpublished) validation of the scale [144, 150]. Independent validation studies have generally supported the PENS factor structure as originally specified [31, 92, 93]; however, it remains unclear whether intuitive controls and competence represent distinct subscales (particularly for experienced players) [92, 93], and issues with some presence/immersion items (#4 and #8) have recurred across studies [Johnson, personal communication]. Recently, a new measure of in-game need satisfaction – the Ubisoft Perceived Experience Questionnaire (UPEQ) [7] – was created by game developers, using items adapted from existing SDT instruments.

A notable development in SDT-based games research is the *need density hypothesis*, which proposes that individuals whose basic needs are poorly satisfied or actively thwarted [145] in day-to-day life are more likely to develop an unhealthy preference for the comparatively “dense, consistent, and immediate” [160, p. 529] experiences of need satisfaction in videogame play [152, 151, 160]. It was formulated to reconcile videogames’ need-satisfying qualities with the potential emergence of dysfunctional play behaviours. Although applied work on the topic is limited, early findings [3, 14, 145] have found some support for the hypothesis.

Motivation

Together with need satisfaction, *motivation* arguably constitutes the key construct underlying SDT. According to Deci and Ryan [47], motivation consists of the *energy* to take action, as well as the *direction* in which this energy is then moved

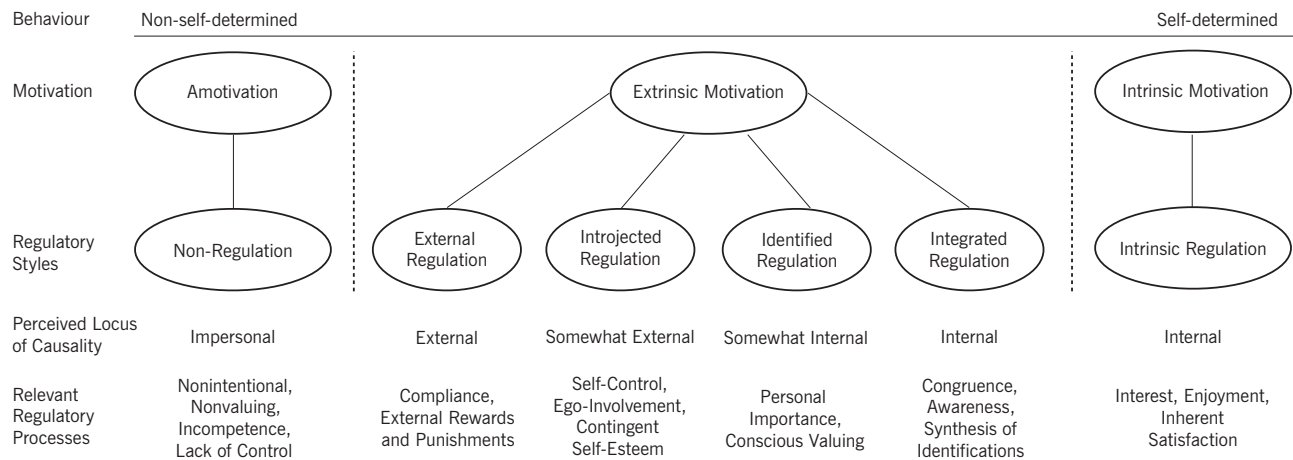


Figure 2. The different motivations and regulations posited by Organismic Integration Theory (OIT), ranging from the least self-determined (amotivation) to the most self-determined (integrated regulation and intrinsic motivation). Adapted from [161].

(i.e., approaching or avoiding a given instance). As pictured in Figure 2, SDT broadly differentiates three types of motivation [157]: *Intrinsic motivation* denotes activity pursued for its inherently interesting or enjoyable qualities. *Extrinsic motivation* refers to activity pursued for a separable outcome. *Amotivation* denotes the absence of intentional motivation, where a person may no longer be aware why they pursue an activity.

One of the key mini-theories underlying motivation is *Cognitive Evaluation Theory* (CET), which is primarily concerned with the social-contextual factors that support or attenuate an individual's *intrinsic motivation* towards an activity [41, 44, 45, 47]. CET distinguishes between the satisfactions inherent to an activity¹ (i.e., basic need satisfaction), and *extrinsic rewards*, which are separable from the activity itself (e.g., money). Extrinsic rewards undermine intrinsic motivation to the extent that their conferral devalues the activity itself and controls further engagement [43]. The extent to which rewards (or other stimuli) are perceived as comparatively informational, controlling, or amotivating (i.e., their *functional significance*) changes their influence on need satisfaction, and hence intrinsic motivation (Figure 1).

In contrast to CET, *Organismic Integration Theory* (OIT) primarily attends to the processes that influence *extrinsic motivation* [157, 49]. The quality of extrinsic motivation varies to the extent that instrumental outcomes become internally valued, which occurs through the process of *internalisation* [49] (Figure 2). *External regulation*, for instance, is the least self-determined form of extrinsic motivation and typically occurs in situations where people act to obtain a reward or avoid punishment. *Introjected regulation* describes a regulation which has been partially internalised but not truly accepted as one's own. Such behaviours are pursued to avoid guilt or shame or to achieve feelings of self-worth or approval. In contrast, *identified regulation* follows from the conscious valuing of an activity as personally important. Finally, *integrated regulation*

¹Early CET works employ the term “intrinsic rewards” [41, 45], which is no longer used in contemporary SDT research, but remains prevalent in computational approaches to intrinsic motivation that draw from SDT (e.g., [23, 131]).

is the most self-determined form of extrinsic motivation and results when an activity is congruent with personally endorsed values, goals, and needs that are already part of the self.

Game enjoyment has been frequently assessed via the Interest/Enjoyment construct of the Intrinsic Motivation Inventory (IMI) [124, 166]. The Gaming Motivation Scale (GAMS) [104] differentiates the six regulatory styles posited by OIT. More recently, Brühlmann et al. [32] and Peters et al. [136] developed OIT-based measures for UX research that could also be adapted for studies of games and play.

Other SDT mini-theories

Lastly, SDT contains mini-theories that focus on more temporally stable traits. According to *Causality Orientation Theory* (COT) [46, 190], for instance, people differ in the extent to which they experience their actions as self-determined. Autonomy oriented individuals are more likely to act according to their own interests and values and interpret external events as informational rather than controlling [46, 190], therefore experiencing more competence need satisfaction. Control oriented people are more likely to act due to external demands and perceive external events as pressuring, and consequently experience less autonomy. Lastly, an impersonal orientation describes the extent to which people focus on obstacles to goal attainment and perceive a lack of control over outcomes, rendering them more prone to amotivation.

While SDT is largely concerned with motivation – or “why” a goal is pursued [47] – “what” goals are pursued is central to *Goal Contents Theory* (GCT) [159]. GCT differentiates extrinsic goals, which reflect instrumental values (e.g., wealth and fame), and intrinsic goals, aspirations that are valuable in themselves (e.g. personal growth, fulfilling relationships). Intrinsic goals are more strongly linked to beneficial wellbeing outcomes. Finally, *Relationships Motivation Theory* (RMT) [162] emphasises the value of mutual autonomy support in developing and maintaining high-quality relationships with close others and in groups.

To date, these mini-theories have received limited attention within games-related research, with only COT having been studied in the context of gamification [125, 198].

REVIEW METHOD

The purpose of this review was to investigate how, why, and (ultimately) to what effect SDT has been mobilised to advance HCI games research. The reviewing procedure followed previous systematic reviews on UX and HCI games research (e.g., [11, 106, 124]).

Source selection

Publications considered for review were drawn from the proceedings of CHI and CHI Play, as they represent foundational venues for research on games and play in HCI. We acknowledge that this approach precludes works that have been published in other relevant venues (e.g., *Computers in Human Behavior*, *International Journal of Human-Computer Studies*, *Foundations of Digital Games*), but opted to focus on the flagship venues for HCI games research.

We searched the Scopus database, which (at time of writing) contains an up-to-date list of publications from both venues. Publications from any year were considered.

Search procedure

Our query (see supplementary material) searched for the collective terms *self-determination*, *theory*, and *game* across all sections of the text (i.e., abstract, paper text, references). These search terms are featured in the title of the original paper by Ryan et al. [166], which has been widely cited in games research, as well as related research areas (e.g., gamification, [60]). Searching the CHI and CHI Play proceedings in this way returned 166² publications.

Screening criteria

Only full papers were included for further consideration. Most screening at this step was automatic: Scopus lists CHI Play full papers and extended abstracts in separate proceedings, but fails to do so for earlier installments of CHI. Extended abstracts (n=37) were manually removed by the first author, as these papers are not expected to contain a complete literature review, and may have complicated interpretation of our findings. In total, 129 publications remained after this step.

Selection of papers for inclusion in the review

Because we were interested in understanding the ways that games research within HCI applies and discusses SDT and its concepts, we excluded all papers lacking substantial relevance to either SDT or games (n=19, see supplementary material for the full list). Both authors agreed on all exclusions made on this basis. Papers were considered relevant to SDT when the theory pertained to the main content of the text (e.g., due to scale use). For example, the work of Harpstead et al. [80] was excluded for this reason, as it only mentions SDT in a list of theories applied in another study. When assessing relevance to games, we chose to avoid limiting ourselves to a particular definition of “game” or “play”, and accepted any interpretation of “game-ness” made by the paper’s authors. A paper excluded on this basis, for example, was [32], which, while drawing from SDT, is about technology use in general.

²Note that the initial search was conducted in July 2019, before the CHI PLAY 2019 proceedings were available, which yielded 150 publications. The query was repeated for the camera-ready version.

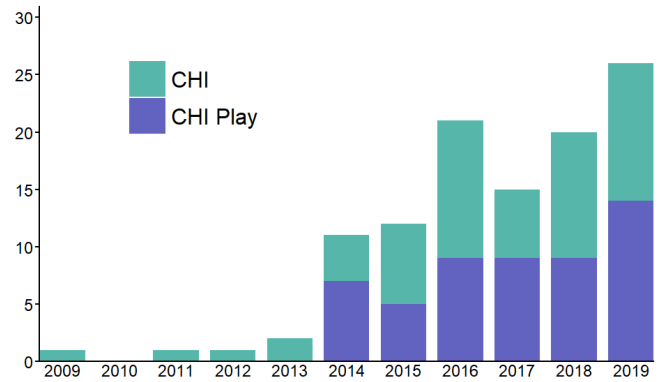


Figure 3. Number of reviewed papers (N=110) referring to SDT per year and per publication venue. Note that CHI PLAY proceedings were first published in 2014.

Coding procedure

To generate initial coding categories, both authors read and discussed 6 papers randomly selected from the final sample (N=110), none of which were authored by us. The remaining papers were split between authors, with weekly meetings to discuss and iterate coding categories, after which previously coded papers were revisited. As a result, papers were coded with respect to venue, research domain (e.g., gamification), study type, SDT-related measures, purposes for citing SDT, SDT-related references, SDT concepts named, concept definitions (if provided), observed relations involving SDT concepts, claims made about SDT, and variations in terminology use. Papers co-authored by one of the authors or their research group were coded by the other author. The coding spreadsheets are included as supplementary material.

RESULTS

As shown in Figure 3, the number of papers that cite SDT has increased substantially since 2014, both with the launch of CHI PLAY, but also at CHI. While we can only speculate as to why SDT grew more prominent then, we note a marked increase in papers employing the PENS in 2014. The following section reports our analysis of the 110 papers reviewed, in which we summarise where, how, and why SDT is applied in current HCI games research.

Research Domains

In total, we identified 24 distinct domains within HCI games research where SDT was applied. The most prevalent topic studied in our sample was *player experience*, which was investigated in over half (61.82%) of all reviewed papers. This category included work that was primarily concerned with how games shape the player experience; for instance, genre-specific experiences [89], the influence of avatar customisation on intrinsic motivation, [17], or experiences of emotionally moving play [24].

Other prominent categories included *design and interaction techniques* (21.82%), which featured a case study of a dungeon-crawling game with Twitter integration [84], and *gamification* (18.18%), for instance, on supporting driver engagement [176]. Less commonly, SDT was employed to inform the design of games or game-adjacent systems [8, 61].

The remaining papers varied widely in subject matter – for example, employing SDT to pursue more realistic player AI [73, 154]; understand women’s motivations, attitudes, and experiences with respect to videogame play [170]; and evaluate the effectiveness of game-based advertisements [4].

Concepts, Mini-theories and Measures

Engagement with mini-theories and key concepts

To review, SDT’s formal propositions are situated in 6 mini-theories that are organised around central concepts (e.g., intrinsic motivation) and backed by empirical findings [165]. However, we observed only 3 instances of direct engagement, whereby a mini-theory was explicitly named in the reviewed literature, and all referred to Cognitive Evaluation Theory (CET). Birk and Mandryk [16] summarise CET as foundational theory in their research on personality and game controllers, though it does not reappear as a lens with which to interpret results; Deterding [59] employs CET as a means to understand the ways that public and private contexts can influence player autonomy; finally, Guckelsberger et al. [73] discuss CET in conversation with their empowerment-based theory of intrinsic motivation, drawing comparisons between the two: “(CET) highlights the critical role of a person’s competence and autonomy in intrinsic motivation [...] We believe that empowerment relates to autonomy in that it quantifies the availability of actions in different game states, and relates to competence in terms of effectance” [73, p. 9].

In contrast, we observed substantial *implicit* engagement with SDT’s mini-theories through their organising concepts. Need satisfaction concepts were by far the most frequently mentioned – competence was discussed in 84.55% of the sample, with somewhat less interest in autonomy (65.45%) and relatedness (57.27%). This comparatively wide margin may reflect the conceptual relevance of competence in research on flow (e.g., [112, 113]), dynamic difficulty adjustment (e.g., [9, 40]) or self-efficacy theory (e.g., [82, 86]). Few papers examined need satisfaction as a means to develop knowledge of motivational and wellbeing-related outcomes via SDT (e.g., [192]). More often, competence, autonomy, and relatedness were mobilised for *evaluation* – as factors that “lead to a better gaming experience” [140, p. 4], or as evidence that “basic player experience was positive” [84, p. 5]. In these papers, the value of need satisfaction is largely inherent, and to some extent distinct from its importance to SDT. Reinschluessel et al., for example, combine aspects of CET with neurofeedback terminology [146, p. 186]: “positive reinforcement [...] has been shown to significantly increase the person’s perception of their own performance, which leads to increased intrinsic motivation to do a task”.

While intrinsic motivation was also frequently deployed (54.55%) as a concept, extrinsic motivation was only discussed in 20.91% of the papers reviewed. This comparatively muted interest extends to *internalisation* (5.45%), and Organismic Integration Theory (OIT), which governs both concepts but was not directly mentioned in any papers we reviewed. Finally, two papers implicitly referred to goal contents theory (GCT) through their discussion of intrinsic goals in game design [73,

p. 3] and the extrinsic goal orientation implied in cheating behaviours [94, p. 766].

Inconsistencies and Misconceptions

We noted some inconsistencies concerning how SDT concepts were understood in the reviewed papers. With regards to autonomy, for instance, some papers considered it with respect to engaging in play under one’s own volition (e.g., [59, 98, 110]), while others focused on in-game autonomy, “the interesting options the game offers” [52, p. 36], where “players are provided with a lot of freedom in strategy planning and action selection” [140, p. 3166]. The definition provided by Birk and Mandryk synthesises these two perspectives: “CET proposes that the experience of autonomy derives from volition and willingness to perform a task. For example, multiple in-game options give players cause to experience autonomy through willing decision-making” [16, p. 686].

Other works provided more cryptic definitions, describing autonomy as “seek to be causal agents while maintaining congruence with the self” [95, p. 6], or referring to it as “a sense of freedom and independence” [90, 91] – although outside of games, autonomy and independence were found to be empirically distinct [37]. In one instance, autonomy was defined in terms that do not readily correspond to its conceptualisation in SDT: “Autonomy means the more in control of a situation a person feels, the more likely they are to succeed” [180, p. 230].

Similarly, we observed variations in SDT terminology, where the exact meaning was left unclear. For instance, Reinschluessel and Mandryk state that “the inability of participants to exert control over the avatar through self-regulation resulted in demotivation” [146, p. 194]. What is meant by “demotivation” remains ambiguous, however; the term is linked to specific electroencephalography parameters, yet no significant effects regarding various SDT-based measures (i.e., IMI, PENS) were observed. In another example, Rooksby et al. [155] refer to various SDT concepts (e.g., need satisfaction, internalisation), before focusing on “individual-competence” and “social-relatedness”, concepts they attribute to [148] – even though the latter does not mention these terms or SDT.

A curiously prevalent misconception emerged in the ways extrinsic motivation was conceptualised, particularly with respect to internalisation. First, extrinsic motivation was frequently conflated with *external regulation* [28, 29, 53, 66, 147] – its least self-determined form – for example, when defined as being “driven by external rewards” [53, p. 3]. Second, proximal definitions of intrinsic and extrinsic motivation sometimes failed to acknowledge that need satisfaction benefits both forms of motivation [21, 66, 97, 147], as in Kappen et al. [97, p. 7], who introduce internalisation before noting that “intrinsic motivation is facilitated when autonomy, competence, and relatedness—the three psychological needs of human motivation—are satisfied”.

Measures

Overall, 63.64% (n=70) of the reviewed papers employed at least one measuring instrument based on or adapted from SDT, although the rationales for doing so varied widely.

Scale	Subscale	N	%
IMI (n=44)	interest/enjoyment	44	40.00
	effort/importance	25	22.73
	pressure/tension	26	23.64
	value/usefulness	3	2.73
	perceived competence	15	13.64
	perceived choice	3	2.73
PENS (n=44)	competence	42	38.18
	autonomy	40	36.36
	relatedness	27	24.55
	presence/immersion	28	25.45
	intuitive controls	26	23.64

Table 1. IMI and PENS use in HCI games research. Data do not sum to 100% (Sample N=110), as many papers use multiple measures.

The Intrinsic Motivation Inventory (IMI) was used in 40.00% of the reviewed papers to assess intrinsic motivation or enjoyment (see Table 1). Almost half of these did not state reasons for using the IMI. Rationales otherwise referred to the scale's prior use in games research, independent validation, or other factors – for example, one study employed IMI subscales "...as additional dimensions rooted in SDT to augment the PENS results" [174, p. 5]. The most common citation to accompany the IMI describes an independent validation study from McAuley et al. [122], which may represent implicit justification for using the scale.

Notably, McAuley et al. [122] did not validate the full 42-item IMI (which is publicly available on the official SDT website [35]); instead, the authors pre-selected 4- and 5- item measures of interest/enjoyment, perceived competence, effort/importance, and pressure/tension for their analyses. Contra the scale authors, who consider interest/enjoyment "the self-report measure of intrinsic motivation" [35], McAuley et al. conclude on a factor analytic basis that intrinsic motivation is a function of the four IMI dimensions they assessed.

Crucially, these conflicting approaches to measuring and operationalising intrinsic motivation have quietly carried into the HCI games literature (only Phillips et al. [139, p. 4] appear to concede that "there are numerous versions of the measure, with minor variations to certain items"). Some scholars (e.g., [196, 62, 193]), in line with the scale authors, employed the interest/enjoyment dimension only. Others matched McAuley et al., operationalising intrinsic motivation as a function of interest/enjoyment, perceived competence, effort/importance, and pressure/tension (Table 1). One paper [1] describes using the Task Evaluation Questionnaire – a 22-item IMI variant listed in the official Scale Description document [35] – with attribution to Deci et al. [42], who used a different IMI variant. Finally, a minority of studies selected individual questionnaire items patterned after the IMI [72, 114, 115].

The PENS was employed in 40.00% of papers reviewed, with competence (38.18%) and autonomy (36.36%) dimensions most frequently assessed (Table 1). This likely reflects their centrality in CET. PENS use was often justified with respect to its apparent capacity to "explain" [16, 28], "assess" [84, 65], or "measure" [89, 197] player experience as a whole, where need satisfaction was referred to as a "core PX concept" [24]. Other reasons for employing the PENS included its use in

previous HCI games research (e.g., [83, 89]), its capacity to "directly inform game design decisions" [174, p. 5597] or by reference to other authors' claims of its utility – which, in one example, included the scale authors themselves [95].

A smaller number of papers explained their use of the PENS in greater detail. Phillips et al. [139, p. 396], for example, highlight that "player experience is multifaceted in nature, and no holistic measures exist [...] due to the large conceptual overlap between rewards and motivation, we opted to focus on player experience constructs that relate to self-determination theory". While not explicitly referring to SDT, a study on emotional challenge notes that "in PX research, challenge and competence are often considered to be related, albeit distinct constructs" [26, p. 4], suggesting the potential relevance of the PENS competence measure.

While the PENS and IMI were clearly the most popular SDT-based measures used, a total of 15 papers assessed SDT concepts by alternative means. Specifically, we observed the measurement of basic need satisfaction via the Ubisoft Perceived Experience Questionnaire (UPEQ) [108], Player Experience Inventory (PXI) [83], and Basic Psychological Need Satisfaction scale (BPNS) [54]; intrinsic motivation via measures of free-choice behaviour [17, 29, 112, 113], and scale items adapted from other measures [15, 133]; intrinsic and extrinsic motivations via the Situational Motivation Scale (SIMS) [2, 20, 87], Gaming Motivation Scale (GAMS) [170], and Exercise Self-Regulation Scale (SRQ-E) [86]; and autonomy support via the Sport Climate Questionnaire (SCQ) [6].

Purposes for Citing SDT

Somewhat surprised by the limited explicit engagement with SDT mini-theories, and the fact that few of the reviewed papers provided a theory-driven rationale for employing SDT-based measures, we became interested in the reasons *why* SDT was cited, following similar endeavours on the uses of Activity Theory and the Trajectories Framework in HCI [38, 195]. We initially coded papers in our corpus according to the purposes of HCI theory outlined by Rogers [153], Bederson and Shneiderman [13] – for instance, using theory to "describe objects and actions in a consistent and clear manner to enable co-operation" [13, p. 239]. However, as these categorisations alone were not sufficiently granular, our analysis also examined where SDT was cited in the text (e.g., Related Work, Discussion), and to what extent each paper related their own work to the theory. Note that purposes for citing SDT were not mutually exclusive.

Descriptive

Overall, the majority of papers (82.73%) treated SDT mainly in a descriptive manner, restating the core tenets – often cursorily only – without properly explicating or positioning them in the context of the work. Many of these "throwaway" citations [121] seemed rather tenuously related to the presented work, and in some cases tautological, as in "designing (the activity) to be intrinsically motivating through appealing to intrinsic motivation" [119, p. 377], or "Ryan et al. have demonstrated that video games can be a means of needs satisfaction because they allow players to experience competence, autonomy, and

relatedness” [69, p. 1581] – both the only statements linked to SDT in their respective papers.

As the previous section might suggest, several works chiefly cited SDT because they *employed SDT-based measures*, with few providing more than a (brief) description of the theoretical considerations underlying these questionnaires. Bowey et al. [28], for instance, employed the IMI and the PENS, and provide a relatively lengthy description of the corresponding concepts, noting that “The most prevalent model that explains player experience is the satisfaction of needs during play, which is part of the broader context of self-determination theory” [28, p. 1532]. However, SDT is not mentioned again in the paper. Indeed, few papers employing SDT-based measures brought up SDT in the Discussion section beyond a simple summary of their study findings; for example, “Player experience was also strongly affected [by latency], with substantial changes to enjoyment, frustration, perceived competence, and attribution as latency increased” [114, p. 293].

Papers that did not employ SDT-based measures appeared to cite SDT primarily as a means to *motivate the authors’ own work*. Hall et al. [77, p. 122], for instance, deployed SDT as Related Work to draw links between games and learning, commenting that “designing games to support autonomy, competence, relatedness [...] can help facilitate enjoyment, ongoing gameplay and consequently result in meaningful learning outcomes”. However, no further explanations of how game design might promote need satisfaction nor how it may enhance learning are provided, and SDT is not brought up again in the paper. Other papers only referred to SDT in their Discussion, perhaps with the intent to *situate their work within a well-established theoretical framework*; e.g., “Drawing from SDT [...] the appeal and well-being effects of video games are based in their potential to satisfy basic psychological needs for competence, autonomy, and relatedness. [...] In a similar vein, our study showed how players developed negative emotions from the sense of loss of control in interactions with the complex game systems” [100, p. 9].

Notably, descriptive uses of SDT were not necessarily brief – several papers provided lengthy descriptions of SDT concepts and listed numerous SDT references. Kappen et al. [97], for instance, cite 12 SDT-based papers on games and physical exercise, yet eventually resort to a questionnaire that, according to the scale authors, “presents problems trying to embed the study of surface-level participation motives within self-determination theory” [118, p. 374].

Explanatory

Although the majority of papers engaged with SDT in a descriptive manner, several papers (27.27%) quoted SDT to provide *theoretical explanations that formed the starting point for their empirical investigations* – sometimes in conjunction with other theories (e.g., empowerment, flow, motive disposition theory, [73, 141, 174]). A few works formulated specific hypotheses derived from SDT or SDT-inspired studies [110, 174], or otherwise clearly built upon SDT propositions, e.g., “One interpretation is that autonomy is thwarted when playing for money and unimpeded when internalised by a sense of value from the task [...] Another interpretation is that different

types of rewards may have different behavioural or motivational outcomes. Examining the role that reward types play may better position future research exploring the impact of rewards” [139, p. 395]. In other instances, SDT’s relevance to the work was less clearly explicated; for example, citing competence satisfaction to explain the motivational benefits of exaggerated avatar movement in virtual reality: “Games can empower players beyond reality, [...] Such superhuman abilities can be argued to support basic psychological needs such as the feeling of competence (which) is also central to sport and exercise motivation” [72, p. 201].

However, the difference between descriptive and explanatory uses of SDT was not always obvious, as some papers provided post-hoc explanations of their findings – that is, it is unclear to what extent SDT figured into formulating the research question, before the study findings were known. For example, in explaining their findings in the context of their previous work on games and wellbeing, Johnson et al. note that “it is encouraging given that the PENS measure of relatedness is based on self-determination theory and hence, feelings of relatedness experienced during gameplay can be expected to contribute positively to overall wellbeing” [91, p. 3727].

Beyond explanation, two papers discussed the potential for SDT to *predict and simulate player motivation* in AI-based playtesting [73, 154]. However, Roohi et al. note that “‘appraisal theory provides more clear concepts that can be implemented as AI code, although it might be less well known in the game research community than player type research or SDT” [154, p. 8], suggesting that more work is necessary to translate SDT propositions into AI models.

Importantly, explanatory engagement with SDT did not preclude theoretical misconceptions: Tondello et al., for instance, claim that “Especially, SDT provides the theoretical background for the Hexad model concerning the expression of both intrinsic and extrinsic motivation” [180, p. 230]. However, statements such as “Players are motivated by extrinsic rewards. They will do whatever to earn a reward within a system, independently of the type of the activity” [180, p. 231] are not backed by SDT, nor have they been empirically supported by the Hexad authors through SDT-based measures.

Design

Several works (8.18%) cited SDT to *formulate design recommendations*, thereby employing the theory in a more prescriptive or even generative manner [13, 153]. However, some of these “Implications for Designers” remained fairly descriptive, as in the case of varying health bars so that “we can artificially manipulate competence, which has implications for perceived game difficulty” [202, p. 10], or “breaking” player autonomy, as “deliberately restricting player autonomy can make for an intensely emotional experience, when players care for characters” [24, p. 3003].

However, a few works explicitly “discuss how theories of motivation (and in particular SDT) were useful in encouraging a design focus that was broader than the individual, and furthermore this helped to guide very specific design decisions” [8, p. 3079]. The same authors later note, however, that “theory

offers little insight into identifying what will be motivating for an individual”. In contrast, Vanden Abeele et al. [188] appear more successful in applying SDT – among other work linked to intrinsic motivation (e.g., [117]) – to critically analyse an existing game design used to assess young children’s perception of acoustic stimuli, and inform their own (more motivating) design with the same aim; e.g., “To provide a way to increase learner control and autonomy, we added an extra scene [...] While this has no influence on the actual performance on the tests, this does give the child freedom of choice, and perhaps a feeling of control and autonomy” [188, p. 334].

SDT-inspired design considerations were not only concerned with *game* design, as in the case of Dodero et al., who drew from SDT to gamify the co-design process for school children: “Progression maps can also be used to connect with others and satisfy relatedness needs [...] and are available for sharing their co-design experience and acquired expertise” [61, p. 79].

Again, despite more in-depth engagement with SDT tenets, we observed some ambiguous statements among SDT-based implications for design. For instance, one paper describes points as “external rewards” that promote extrinsic regulation [21, p. 292], but in the discussion suggests promoting intrinsic motivation through “feedback in the form of scores, stars, or achievements to reinforce the experience of competence” [21, p. 299], without specifying the circumstances under which points might function as informational or controlling feedback.

Conceptual

Finally, two of the reviewed papers were notable for applying SDT to *develop and advance conceptual frameworks* of motivation in the context of games, play, and game-adjacent systems. First, several of the Hexad player types [130, 180] – despite certain theoretical misconceptions – are largely based on satisfaction of the needs for autonomy, competence and relatedness, as well as extrinsic motivation. Second, Deterding [59] established a grounded theory of contextual autonomy support in leisurely play. Based on an extensive review of SDT and an interview study about leisurely and work-related game play, the model outlines concrete and empirically testable propositions about the impact of social, spatial, and temporal factors on autonomy satisfaction.

DISCUSSION

Self-determination theory (SDT) constitutes one of the major motivational theories in mainstream psychology, and has increasingly risen to prominence in the domain of games research, as well as the games industry [7, 85, 189]. This paper has presented a review of 110 papers that cite self-determination theory to investigate how, why, and (ultimately) to what effect SDT has been mobilised to advance HCI games research. It is clear from our findings that SDT has had a substantial impact on HCI games research, as evidenced by the growing number of CHI and CHI Play papers that cite the theory. Key SDT concepts, such as intrinsic motivation and need satisfaction, are quoted across a range of research domains, methodologies and contributions – including design [6, 155], player modelling [40, 73], and gamified wellbeing interventions [20, 194]. Moreover, more than half of the reviewed papers employed SDT-based measures to investigate

aspects of the player experience. However, the majority of papers engage with SDT in a limited manner: mini-theories are rarely mentioned, and few works appear to consider theoretical propositions in detail.

Crucially, our review has established that HCI games research figures SDT less as a *theory*, and more as what Rogers [153] has described as a *paradigm* – “a set of practices that a community has agreed upon, (including) questions to be asked and how they should be framed; phenomena to be observed, how findings from studies are to be analyzed and interpreted” (p. 4). In the following, we integrate our findings – regarding *how* HCI games scholars employ SDT in research, *why* the theory is cited, and *what* is already known – to highlight conceptual gaps, and identify ways that HCI games research could employ SDT more productively in future.

How SDT Has Contributed to HCI Games Research

While the citation numbers of the original SDT games papers [144, 166] hint at their impact, we were specifically interested in *how* SDT has contributed to HCI games research. First, HCI games scholars employ SDT to study a variety of topics, ranging from more common intersections such as player experience and gamification, but also AI player modelling, Feminist HCI, and in-game advertising. This variation in subject domains reflects the multiplicity of research conducted within HCI games research, and SDT’s suitability as a general framework for studying human activity [165].

Second, as our review shows, SDT has been useful for establishing a vocabulary to describe and discuss PX. SDT concepts, such as intrinsic motivation and need satisfaction, are often quoted to motivate novel research and broadly situate it within a well-known theoretical framework. Arguably, one of the major strengths of SDT is the provision of concepts that are intuitive to understand and relevant in the context of games, even for researchers (and reviewers) with no background in motivational psychology.

Third, HCI games research often turns to SDT for instrumental reasons – in particular, to employ the PENS or IMI as a measure of player experience. In light of the plurality of player experience measures [52, 93, 106, 124] – few of which have ever been formally validated – a set of commonly accepted measures is valuable for discussing and comparing findings across different studies and domains, and help establish a growing corpus of knowledge around HCI games research. Whereas prior reviews of HCI research on UX or game enjoyment observed a tendency towards unstandardised and ad-hoc measures in the literature [11, 124], the popular use of independently-validated instruments in our review indicates substantial progress in this area.

Lastly, beyond merely motivating the presented work, we observed a variety of ways in which SDT informed research and design. As expected from a scientific theory, several works posited specific hypotheses or otherwise formulated research questions derived from SDT, which were subsequently empirically examined – often using SDT-based measures. Moreover, several works applied SDT as a lens to formulate game design recommendations, inform the design process, or analyse

existing designs. This suggests that SDT may indeed also serve *practical* purposes [164] – although the resulting design recommendations may be more effective as fairly general best practices and heuristics [187] rather than what will be motivating to an individual [8, 141]. That said, our sample also included endeavours to translate SDT propositions into parameters that can be implemented into AI models to predict and simulate the player experience [73, 154]. Finally, SDT also formed the starting point for the development of conceptual frameworks around games and gamification [59, 180].

Shallow Engagement with SDT

Surprisingly, given the aforementioned contributions, we observed that the majority of papers engage in a rather shallow manner with SDT. Few papers made explicit reference to SDT mini-theories and the majority of reviewed papers provided merely descriptive accounts of the theory, with SDT used as a stepping stone to the principal topics of study.

We also note that several papers we analysed were fraught with dubious (and often uncited) claims as to how individual game elements relate to SDT concepts (e.g., [82, 180]), in line with similar observations in the context of gamification research [116]. As noted earlier, SDT champions itself as being practical, in that “it points to how features of contexts [...] facilitate or undermine motivation” [164, p. 4]; and critical, as a means to “examine proximal social contexts [...] as well as more pervasive cultural, political, and economic conditions in terms of their adequacy in supporting versus impairing human thriving” [164, p. 4]. These strengths are not currently reflected in HCI games research. Indeed, the prevalence of incorrect or specious interpretations of SDT concepts and propositions is concerning – at worst, a tenuous grasp of SDT could produce misleading implications for the design and evaluation of games, play, and game-adjacent systems, with potentially adverse effects on player motivation and wellbeing.

The prevalence of the PENS and IMI in player experience literature may seem self-evident, given that the PENS was developed to capture aspects of PX [150], and the IMI is fairly well-established as a measure of game enjoyment [124]. However, despite their prevalent use, there is no consensus as to what phenomena the IMI and PENS are intended to capture: it remains unclear whether PENS measures of need satisfaction *constitute* PX, or rather its antecedents; separately, the field is split as to operationalising intrinsic motivation either as IMI interest/enjoyment alone, or additionally incorporating its effort, tension, and (potentially) perceived competence constructs. We highlight that consensus has remained elusive not as the result of cogent and well-considered arguments from all sides, but rather, the absence of such debate in HCI games literature. As noted earlier, the divergent views on the IMI originated in SDT, reflecting positions maintained by the scale authors [35, 164], relative to claims made in a widely-cited validation study [122]. Rather than arguing for either position, we emphasise here that this wholesale and undeclared adoption of a disagreement external to HCI games research has complicated comparisons of study findings between papers, and limited the pool of related work from which future studies may draw.

Curiously, even when SDT concepts are measured, the theory is rarely used to directly inform hypotheses or research questions, or to analyse results. Indeed, many publications in our review appear to primarily refer to SDT to motivate their own work, or provide post-hoc explanations for study findings. With regards to need satisfaction, for instance, many papers describing game design interventions assumed their changes would influence the player experience in some way. However, fewer papers provided an explanation as to *why* or *how* they expected the intervention to affect need satisfaction.

Future Directions: How to Use SDT More Productively

Despite its contributions, SDT remains underutilised as a theory in HCI games research, and this limits our ability to more productively use prior work to inform research involving need satisfaction, motivation, and wellbeing. These are problematic outcomes that occur largely due to lack of engagement with the theory. However, our findings highlight a number of ways that HCI games research can apply SDT to strengthen research contributions and help develop incremental knowledge:

First, we recommend that authors more systematically contextualise their research questions and findings within existing SDT-based research, especially HCI games research. This does not necessarily require in-depth engagement with SDT’s propositions, rather it serves to clarify and synthesise findings. This can be achieved, for instance, by specifying whether one’s work focuses on autonomy as a function of the game design (e.g., the options that a game provides) or the context of play (e.g., fully volitional play vs playing for learning). Moreover, works that employ SDT-based measures, such as the IMI and PENS, can easily compare findings with previous studies that have used the same measures.

Second, HCI games researchers should more explicitly consider SDT to identify gaps in the games literature and formulate novel research questions. As noted, several of the reviewed studies implicitly assume that their designs and manipulations will impact motivation and need satisfaction in some way (e.g., [15, 29, 168]), but few explicate why they expect these results. Instead, SDT may be used to hypothesise (apriori) and explicate (post-hoc) why a particular game aspect of interest relates to the player experience. A recent SDT textbook [163], for example, lists concrete propositions for each of the concepts and mini-theories, which could be applied to games. Similarly, Deterding’s framework of contextual autonomy support [59], provides a series of explanatory and testable propositions that is consistent with SDT and directly applicable to games.

Third, several of the reviewed papers reported mixed or inconclusive findings with regards to SDT-based measures, e.g., [146]. However, rarely were theory-driven explanations considered when discussing these findings. Explicit engagement with SDT would facilitate identifying theoretical propositions that do *not* readily generalise to particular games or research contexts, or are of limited usefulness to the research aims. Future work can therefore avoid retreading old grounds, or consider other theoretical explanations. Importantly, SDT may also be fruitfully combined with other theories and epistemo-

logical frameworks, as evidenced by some of the reviewed works (e.g., [59, 73, 141, 174]).

Importantly, more in-depth engagement with SDT is not without risks. The Hexad questionnaire [180], for example, claims SDT as foundational literature, and refers to a number of its key concepts – intrinsic and extrinsic motivation, internalisation, and need satisfaction – however, the work exhibits a misleading, and at times incorrect grasp of the theory.

Conversely, authors should highlight when SDT is not of primary relevance to a study (e.g., when merely leveraging the strengths of the PENS or IMI), which frees up space for more relevant topics, and prevents readers from misconstruing the intention of the work. Generally speaking, it is worth identifying relevant theoretical propositions, and whether they can be productively used to inform and strengthen the intended contribution of the work. Where this is not the case, it is fair to resort to the established and fairly well validated measures without delving into the theoretical underpinnings.

Avenues for Future SDT-Based Games Research

With few exceptions, engagement with SDT mini-theories in HCI games research is primarily implicit, in that core propositions and concepts are described as originating from “SDT” generally, or without mentioning the theory at all. Regardless of attribution, HCI games scholars mainly employ concepts from CET (e.g., intrinsic motivation) and basic psychological needs theory. The comparative lack of research involving organismic integration theory is surprising, given the popularity of gamification research (e.g., [53, 97, 110]) and the notion of external rewards (e.g., [139]) in HCI games literature: the value of more self-determined forms of extrinsic motivation for sustained engagement has been consistently demonstrated in internalisation research outside games [63, 134, 200]. As need satisfaction benefits intrinsic motivation and internalisation alike [161], it may be productive to investigate how the design of gamified systems can better support users’ ongoing progress towards important and self-congruent goals and outcomes. Notably, questionnaires that assess the different motivational regulations posited by OIT already exist within HCI [32, 136]. The hierarchical model of intrinsic and extrinsic motivation [185], which conceptualises relationships between motivation and need satisfaction at situational, contextual, and global levels, could inform existing HCI games research concerned with sustained engagement (e.g., [20]).

Relationships motivation theory [50] could also contribute to the development of novel and original hypotheses, adding to existing HCI games scholarship around online multiplayer games and social play (e.g., [89, 193]) – for example, eSports scholars could build from RMT-based studies of ingroup identity (e.g., [107]) to understand the ways that player, coach, and analyst behaviours support or erode team cohesion. RMT could also be applied to research on livestreaming players and the audience communities formed around them; alternatively, the mini-theory could be extended to investigate the relationships that human players often form with (virtual) game characters, following recent work in this area [25, 183].

Research concerning autonomy is surprisingly uncommon in HCI games literature, despite its theoretical importance (i.e.,

to SDT) and complexity. It is notable that Deterding’s context-sensitive model of player autonomy [59] – a rare example of serious engagement with the theory that raises questions around its application to games and play – is yet to see substantial use in HCI games research. The obvious research opportunity here is for HCI games scholars to simply *validate the model* (e.g., with quantitative methods); moreover, a number of questions posed in the work regarding when, how, and why players experience autonomy satisfaction and frustration are yet to be explored in detail.

Limitations of the Literature Review

As mentioned in the review method, we only focused on HCI games flagship venues. For instance, thereby omitting relevant work on SDT and games in media psychology (e.g., [135, 178], gamification (e.g., [125, 167]), and player behavior modelling [126]. We note that games research outside of HCI may similarly lack sufficient engagement with SDT, as noted by previous work in the context of gamification [116, 169]. Moreover, in light of many of the reviewed papers in our corpus engaging with SDT in a cursory manner only, a more in-depth analysis of theory use – akin to the ones by Clemmensen et al. on applications of Activity Theory in HCI [38] and Velt et al. on the Trajectories framework [195] – was not possible. Assessing how and to what ends SDT has been applied in games research outside of CHI and CHI PLAY, or within different HCI domains (e.g., User Experience [32, 105]), could help uncover as of yet untapped avenues for future work.

CONCLUSION

Self-Determination Theory (SDT) has increasingly risen to prominence in HCI games research. Our review of 110 CHI and CHI PLAY paper showcases that SDT has been applied across a wide variety of domains, disciplines and research contributions. Concepts such as intrinsic motivation and need satisfaction are considered core to the player experience and contribute to a shared vocabulary for discussing what makes games engaging. Moreover, the availability of standardised SDT-based measures, such as the IMI and PENS, facilitate empirical research and further popularise these concepts. Despite this popularity, however, prominent SDT concepts and mini-theories are rarely considered explicitly, and few papers engage with SDT beyond descriptive accounts. This is problematic for three reasons: First, it risks the proliferation of theoretical inconsistencies and misconceptions, which undermine the benefits of a shared vocabulary and could result in misleading and invalid research findings. Second, more in-depth engagement with the theoretical underpinnings of SDT-based concepts and measures would facilitate incremental knowledge gains, comparison between works, and integrating seemingly disparate research strands. Third, the propositions posited by the various SDT mini-theories (e.g., CET, OIT) provide largely untapped potential to advance empirical and conceptual research, thereby ultimately contributing to a deeper and more systematic understanding of human-computer interaction in the context of games, play and game-adjacent systems.

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REFERENCES

- [1] * Gazihan Alankus and Caitlin Kelleher. 2012. Reducing Compensatory Motions in Video Games for Stroke Rehabilitation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 2049–2058. DOI : <http://dx.doi.org/10.1145/2207676.2208354>
- [2] * Dmitry Alexandrovsky, Maximilian Achim Friehs, Max V. Birk, Rowan K. Yates, and Regan L. Mandryk. 2019. Game Dynamics that Support Snacking, not Feasting. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 573–588. DOI : <http://dx.doi.org/10.1145/3311350.3347151>
- [3] Johnie J. Allen and Craig A. Anderson. 2018. Satisfaction and Frustration of Basic Psychological Needs in the Real World and in Video Games Predict Internet Gaming Disorder Scores and Well-Being. *Computers in Human Behavior* 84 (2018), 220–229.
- [4] * Maximilian Altmeyer, Kathrin Dernbecher, Vladislav Hnatovskiy, Marc Schubhan, Pascal Lessel, and Antonio Krüger. 2019. Gamified Ads: Bridging the Gap Between User Enjoyment and the Effectiveness of Online Ads. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 182, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300412>
- [5] * Ronny Andrade, Melissa J. Rogerson, Jenny Waycott, Steven Baker, and Frank Vetere. 2019. Playing Blind: Revealing the World of Gamers with Visual Impairment. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 116, 14 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300346>
- [6] * Josh Andres, Julian de Hoog, and Florian 'Floyd' Mueller. 2018. "I Had Super-powers when eBike Riding" Towards Understanding the Design of Integrated Exertion. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 19–31. DOI : <http://dx.doi.org/10.1145/3242671.3242688>
- [7] Ahmad Azadvar and Alessandro Canossa. 2018. UPEQ: Ubisoft Perceived Experience Questionnaire: A Self-determination Evaluation Tool for Video Games. In *Proceedings of the 13th International Conference on the Foundations of Digital Games (FDG '18)*. ACM, New York, NY, USA, Article 5, 7 pages. DOI : <http://dx.doi.org/10.1145/3235765.3235780>
- [8] * Madeline Balaam, Stefan Rennick Egglestone, Geraldine Fitzpatrick, Tom Rodden, Ann-Marie Hughes, Anna Wilkinson, Thomas Nind, Lesley Axelrod, Eric Harris, Ian Ricketts, Susan Mawson, and Jane Burridge. 2011. Motivating Mobility: Designing for Lived Motivation in Stroke Rehabilitation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. ACM, New York, NY, USA, 3073–3082. DOI : <http://dx.doi.org/10.1145/1978942.1979397>
- [9] * Alexander Baldwin, Daniel Johnson, and Peta Wyeth. 2016. Crowd-Pleaser: Player Perspectives of Multiplayer Dynamic Difficulty Adjustment in Video Games. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI Play '16)*. ACM, 326–337.
- [10] * Soumya C. Barathi, Daniel J. Finnegan, Matthew Farrow, Alexander Whaley, Pippa Heath, Jude Buckley, Peter W. Dowrick, Burkhard C. Wuensche, James L. J. Bilzon, Eamonn O'Neill, and Christof Lutteroth. 2018. Interactive Feedforward for Improving Performance and Maintaining Intrinsic Motivation in VR Exergaming. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 408, 14 pages. DOI : <http://dx.doi.org/10.1145/3173574.3173982>
- [11] Javier A. Bargas-Avila and Kasper Hornbæk. 2011. Old Wine in New Bottles or Novel Challenges: A Critical Analysis of Empirical Studies of User Experience. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. ACM, New York, NY, USA, 2689–2698. DOI : <http://dx.doi.org/10.1145/1978942.1979336>
- [12] Kimberley J. Bartholomew, Nikos Ntoumanis, Richard M. Ryan, Jos A. Bosch, and Cecilie Thøgersen-Ntoumani. 2011. Self-Determination Theory and Diminished Functioning: The Role of Interpersonal Control and Psychological Need Thwarting. *Personality and Social Psychology Bulletin* 37, 11 (2011), 1459–1473.
- [13] Benjamin B Bederson and Ben Shneiderman. 2003. Theories for understanding information visualization. In *The craft of information visualization: Readings and reflections*. Morgan Kaufmann, San Francisco, USA.
- [14] Patrick K. Bender and Douglas A. Gentile. 2019. Internet Gaming Disorder: Relations Between Needs Satisfaction In-Game and in Life in General. *Psychology of Popular Media Culture* Advance publication (2019). DOI : <http://dx.doi.org/10.1037/ppm0000227>
- [15] * Yulong Bian, Chenglei Yang, Chao Zhou, Juan Liu, Wei Gai, Xiangxu Meng, Feng Tian, and Chia Shen. 2018. Exploring the Weak Association Between Flow Experience and Performance in Virtual Environments. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 401, 12 pages. DOI : <http://dx.doi.org/10.1145/3173574.3173975>

- [16] * Max Birk and Regan L. Mandryk. 2013. Control Your Game-self: Effects of Controller Type on Enjoyment, Motivation, and Personality in Game. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. ACM, New York, NY, USA, 685–694. DOI : <http://dx.doi.org/10.1145/2470654.2470752>
- [17] * Max V. Birk, Cheralyn Atkins, Jason T. Bowey, and Regan L. Mandryk. 2016a. Fostering Intrinsic Motivation Through Avatar Identification in Digital Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2982–2995. DOI : <http://dx.doi.org/10.1145/2858036.2858062>
- [18] * Max V. Birk, Benjamin Buttler, Jason T. Bowey, Susanne Poeller, Shelby C. Thomson, Nicola Baumann, and Regan L. Mandryk. 2016b. The Effects of Social Exclusion on Play Experience and Hostile Cognitions in Digital Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3007–3019. DOI : <http://dx.doi.org/10.1145/2858036.2858061>
- [19] * Max V. Birk, Maximilian A. Friehs, and Regan L. Mandryk. 2017. Age-Based Preferences and Player Experience: A Crowdsourced Cross-sectional Study. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 157–170. DOI : <http://dx.doi.org/10.1145/3116595.3116608>
- [20] * Max V. Birk and Regan L. Mandryk. 2018. Combating Attrition in Digital Self-Improvement Programs Using Avatar Customization. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 660, 15 pages. DOI : <http://dx.doi.org/10.1145/3173574.3174234>
- [21] * Max V. Birk, Regan L. Mandryk, and Cheralyn Atkins. 2016. The Motivational Push of Games: The Interplay of Intrinsic Motivation and External Rewards in Games for Training. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 291–303. DOI : <http://dx.doi.org/10.1145/2967934.2968091>
- [22] * Max V. Birk, Regan L. Mandryk, Matthew K. Miller, and Kathrin M. Gerling. 2015. How Self-Esteem Shapes Our Interactions with Play Technologies. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*. ACM, New York, NY, USA, 35–45. DOI : <http://dx.doi.org/10.1145/2793107.2793111>
- [23] Joschka Boedecker, Thomas Lampe, and Martin Riedmiller. 2013. Modeling effects of intrinsic and extrinsic rewards on the competition between striatal learning systems. *Frontiers in Psychology* 4 (2013), 739. DOI : <http://dx.doi.org/10.3389/fpsyg.2013.00739>
- [24] * Julia Ayumi Bopp, Elisa D. Mekler, and Klaus Opwis. 2016. Negative Emotion, Positive Experience?: Emotionally Moving Moments in Digital Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2996–3006. DOI : <http://dx.doi.org/10.1145/2858036.2858227>
- [25] * Julia Ayumi Bopp, Livia J. Müller, Lena Fanya Aeschbach, Klaus Opwis, and Elisa D. Mekler. 2019. Exploring Emotional Attachment to Game Characters. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 313–324. DOI : <http://dx.doi.org/10.1145/3311350.3347169>
- [26] * Julia Ayumi Bopp, Klaus Opwis, and Elisa D. Mekler. 2018. “An Odd Kind of Pleasure”: Differentiating Emotional Challenge in Digital Games. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 41, 12 pages. DOI : <http://dx.doi.org/10.1145/3173574.3173615>
- [27] * Jason T. Bowey, Max V. Birk, and Regan L. Mandryk. 2015. Manipulating Leaderboards to Induce Player Experience. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*. ACM, New York, NY, USA, 115–120. DOI : <http://dx.doi.org/10.1145/2793107.2793138>
- [28] * Jason T. Bowey, Ansgar E. Depping, and Regan L. Mandryk. 2017. Don't Talk Dirty to Me: How Sexist Beliefs Affect Experience in Sexist Games. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 1530–1543. DOI : <http://dx.doi.org/10.1145/3025453.3025563>
- [29] * Jason T. Bowey and Regan L. Mandryk. 2017. Those Are Not the Stories You Are Looking For: Using Text Prototypes to Evaluate Game Narratives Early. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 265–276. DOI : <http://dx.doi.org/10.1145/3116595.3116636>
- [30] Elizabeth Boyle, Thomas M Connolly, and Thomas Hainey. 2011. The role of psychology in understanding the impact of computer games. *Entertainment Computing* 2, 2 (2011), 69–74. DOI : <http://dx.doi.org/10.1016/j.entcom.2010.12.002>
- [31] Florian Brühlmann and Gian-Marco Schmid. 2015. How to Measure the Game Experience? Analysis of the Factor Structure of Two Questionnaires. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 1181–1186. DOI : <http://dx.doi.org/10.1145/2702613.2732831>

- [32] Florian Brühlmann, Beat Vollenwyder, Klaus Opwis, and Elisa D. Mekler. 2018. Measuring the “Why” of Interaction: Development and Validation of the User Motivation Inventory (UMI). In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM.
- [33] * Paul Cairns, Jing Li, Wendy Wang, and A. Imran Nordin. 2014. The Influence of Controllers on Immersion in Mobile Games. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 371–380. DOI : <http://dx.doi.org/10.1145/2556288.2557345>
- [34] * Jared E. Cechanowicz, Carl Gutwin, Scott Bateman, Regan Mandryk, and Ian Stavness. 2014. Improving Player Balancing in Racing Games. In *Proceedings of the 2014 Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 47–56. DOI : <http://dx.doi.org/10.1145/2658537.2658701>
- [35] Center for Self-Determination Theory. n.d. Intrinsic Motivation Inventory (IMI). (n.d.). Accessed 22 August, 2019 from <https://selfdeterminationtheory.org/intrinsic-motivation-inventory/>.
- [36] * Sven Charleer, Kathrin Gerling, Francisco Gutiérrez, Hans Cauwenbergh, Bram Luyckx, and Katrien Verbert. 2018. Real-Time Dashboards to Support eSports Spectating. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 59–71. DOI : <http://dx.doi.org/10.1145/3242671.3242680>
- [37] Valery Chirkov, Richard M Ryan, Youngmee Kim, and Ulas Kaplan. 2003. Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of personality and social psychology* 84, 1 (2003), 97. DOI : <http://dx.doi.org/10.1037/0022-3514.84.1.97>
- [38] Torkil Clemmensen, Victor Kaptelinin, and Bonnie Nardi. 2016. Making HCI theory work: an analysis of the use of activity theory in HCI research. *Behaviour & Information Technology* 35, 8 (2016), 608–627. DOI : <http://dx.doi.org/10.1080/0144929X.2016.1175507>
- [39] * Sebastian Cmentowski, Andrey Krekhov, and Jens Krüger. 2019. Outstanding: A Multi-Perspective Travel Approach for Virtual Reality Games. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 287–299. DOI : <http://dx.doi.org/10.1145/3311350.3347183>
- [40] * Thomas Constant and Guillaume Levieux. 2019. Dynamic Difficulty Adjustment Impact on Players' Confidence. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 463, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300693>
- [41] Edward L Deci. 1976. Notes on the theory and metatheory of intrinsic motivation. *Organizational behavior and human performance* 15, 1 (1976), 130–145.
- [42] Edward L Deci, Haleh Eghrari, Brian C Patrick, and Dean R Leone. 1994. Facilitating internalization: The self-determination theory perspective. *Journal of personality* 62, 1 (1994), 119–142. DOI : <http://dx.doi.org/10.1111/j.1467-6494.1994.tb00797.x>
- [43] Edward L Deci, Richard Koestner, and Richard M Ryan. 1999. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological bulletin* 125, 6 (1999), 627.
- [44] Edward L. Deci and Richard M. Ryan. 1985a. Cognitive Evaluation Theory: Interpersonal Communication and Intrapersonal Regulation. In *Intrinsic Motivation and Self-Determination in Human Behavior*. Plenum Press, New York, USA.
- [45] Edward L. Deci and Richard M. Ryan. 1985b. Cognitive Evaluation Theory: Perceived Causality and Perceived Competence. In *Intrinsic Motivation and Self-Determination in Human Behavior*. Plenum Press, New York, USA.
- [46] Edward L Deci and Richard M Ryan. 1985c. The general causality orientations scale: Self-determination in personality. *Journal of research in personality* 19, 2 (1985), 109–134. DOI : [http://dx.doi.org/10.1016/0092-6566\(85\)90023-6](http://dx.doi.org/10.1016/0092-6566(85)90023-6)
- [47] Edward L. Deci and Richard M. Ryan. 2000. The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry* 11, 4 (2000), 227–268. DOI : http://dx.doi.org/10.1207/S15327965PLI1104_01
- [48] Edward L. Deci and Richard M. Ryan. 2002a. *Handbook of self-determination research*. Rochester, NY: University Rochester Press.
- [49] Edward L. Deci and Richard M. Ryan. 2002b. Overview of Self-Determination Theory: An Organismic Dialectical Perspective. *Handbook of Self-Determination Research* (2002), 3–33.
- [50] Edward L Deci and Richard M Ryan. 2014. Autonomy and Need Satisfaction in Close Relationships: Relationships Motivation Theory. In *Human Motivation and Interpersonal Relationships: Theory, Research, and Applications*. Springer, Dordrecht, Netherlands, 53–73.
- [51] * Alena Denisova and Elliott Cook. 2019. Power-Ups in Digital Games: The Rewarding Effect of Phantom Game Elements on Player Experience. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 161–168. DOI : <http://dx.doi.org/10.1145/3311350.3347173>

- [52] * Alena Denisova, A. Imran Nordin, and Paul Cairns. 2016. The Convergence of Player Experience Questionnaires. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 33–37. DOI : <http://dx.doi.org/10.1145/2967934.2968095>
- [53] * Paul Denny, Fiona McDonald, Ruth Empson, Philip Kelly, and Andrew Petersen. 2018. Empirical Support for a Causal Relationship Between Gamification and Learning Outcomes. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 311, 13 pages. DOI : <http://dx.doi.org/10.1145/3173574.3173885>
- [54] * Ansgar E. Depping, Colby Johanson, and Regan L. Mandryk. 2018. Designing for Friendship: Modeling Properties of Play, In-Game Social Capital, and Psychological Well-being. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 87–100. DOI : <http://dx.doi.org/10.1145/3242671.3242702>
- [55] * Ansgar E. Depping and Regan L. Mandryk. 2017a. Cooperation and Interdependence: How Multiplayer Games Increase Social Closeness. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 449–461. DOI : <http://dx.doi.org/10.1145/3116595.3116639>
- [56] * Ansgar E. Depping and Regan L. Mandryk. 2017b. Why is This Happening to Me?: How Player Attribution Can Broaden Our Understanding of Player Experience. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 1040–1052. DOI : <http://dx.doi.org/10.1145/3025453.3025648>
- [57] * Ansgar E. Depping, Regan L. Mandryk, Colby Johanson, Jason T. Bowey, and Shelby C. Thomson. 2016a. Trust Me: Social Games Are Better Than Social Icebreakers at Building Trust. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 116–129. DOI : <http://dx.doi.org/10.1145/2967934.2968097>
- [58] * Ansgar E. Depping, Regan L. Mandryk, Chengzhao Li, Carl Gutwin, and Rodrigo Vicencio-Moreira. 2016b. How Disclosing Skill Assistance Affects Play Experience in a Multiplayer First-Person Shooter Game. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3462–3472. DOI : <http://dx.doi.org/10.1145/2858036.2858156>
- [59] * Sebastian Deterding. 2016. Contextual Autonomy Support in Video Game Play: A Grounded Theory. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3931–3943. DOI : <http://dx.doi.org/10.1145/2858036.2858395>
- [60] Sebastian Deterding. 2015. The lens of intrinsic skill atoms: A method for gameful design. *Human-Computer Interaction* 30, 3-4 (2015), 294–335. DOI : <http://dx.doi.org/10.1080/07370024.2014.993471>
- [61] * Gabriella Dodero, Rosella Gennari, Alessandra Melonio, and Santina Torello. 2014. Towards Tangible Gamified Co-design at School: Two Studies in Primary Schools. In *Proceedings of the 2014 Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 77–86. DOI : <http://dx.doi.org/10.1145/2658537.2658688>
- [62] * Ignacio X. Domínguez, Rogelio E. Cardona-Rivera, James K. Vance, and David L. Roberts. 2016. The Mimesis Effect: The Effect of Roles on Player Choice in Interactive Narrative Role-Playing Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3438–3449. DOI : <http://dx.doi.org/10.1145/2858036.2858141>
- [63] Jemma Edmunds, Nikos Ntoumanis, and Joan L Duda. 2007. Adherence and Well-Being in Overweight and Obese Patients Referred to an Exercise on Prescription Scheme: A Self-Determination Theory Perspective. *Psychology of Sport and Exercise* 8, 5 (2007), 722–740.
- [64] * Katharina Emmerich and Maic Masuch. 2016. The Influence of Virtual Agents on Player Experience and Performance. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 10–21. DOI : <http://dx.doi.org/10.1145/2967934.2968092>
- [65] * Katharina Emmerich and Maic Masuch. 2017. The Impact of Game Patterns on Player Experience and Social Interaction in Co-Located Multiplayer Games. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 411–422. DOI : <http://dx.doi.org/10.1145/3116595.3116606>
- [66] * Sebastian S. Feger, Sünje Dallmeier-Tiessen, Paweł W. Woźniak, and Albrecht Schmidt. 2019. Gamification in Science: A Study of Requirements in the Context of Reproducible Research. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 460, 14 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300690>
- [67] * Zachary Fitz-Walter, Peta Wyeth, Dian Tjondronegoro, and Daniel Johnson. 2014. Exploring the Effect of Achievements on Students Attending University Orientation. In *Proceedings of the 2014 Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 87–96. DOI : <http://dx.doi.org/10.1145/2658537.2658700>

- [68] * Kathrin Maria Gerling, Regan L. Mandryk, Max Valentin Birk, Matthew Miller, and Rita Orji. 2014a. The Effects of Embodied Persuasive Games on Player Attitudes Toward People Using Wheelchairs. In *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 3413–3422. DOI : <http://dx.doi.org/10.1145/2556288.2556962>
- [69] * Kathrin M. Gerling, Regan L. Mandryk, and Conor Linehan. 2015. Long-Term Use of Motion-Based Video Games in Care Home Settings. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 1573–1582. DOI : <http://dx.doi.org/10.1145/2702123.2702125>
- [70] * Kathrin Maria Gerling, Matthew Miller, Regan L. Mandryk, Max Valentin Birk, and Jan David Smeddinck. 2014b. Effects of Balancing for Physical Abilities on Player Performance, Experience and Self-esteem in Exergames. In *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 2201–2210. DOI : <http://dx.doi.org/10.1145/2556288.2556963>
- [71] Nicolas Gillet, Jacques Forest, Charles Benabou, and Kathleen Bentein. 2015. The Effects of Organizational Factors, Psychological Need Satisfaction and Thwarting, and Affective Commitment on Workers' Well-Being and Turnover Intentions. *Le Travail Humain* 78, 2 (2015), 119–140.
- [72] * Antti Granqvist, Tapio Takala, Jari Takatalo, and Perttu Hämäläinen. 2018. Exaggeration of Avatar Flexibility in Virtual Reality. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 201–209. DOI : <http://dx.doi.org/10.1145/3242671.3242694>
- [73] * Christian Guckelsberger, Christoph Salge, Jeremy Gow, and Paul Cairns. 2017. Predicting Player Experience Without the Player.: An Exploratory Study. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 305–315. DOI : <http://dx.doi.org/10.1145/3116595.3116631>
- [74] * Carl Gutwin, Christianne Rooke, Andy Cockburn, Regan L. Mandryk, and Benjamin Lafreniere. 2016a. Peak-End Effects on Player Experience in Casual Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 5608–5619. DOI : <http://dx.doi.org/10.1145/2858036.2858419>
- [75] * Carl Gutwin, Rodrigo Vicencio-Moreira, and Regan L. Mandryk. 2016b. Does Helping Hurt?: Aiming Assistance and Skill Development in a First-Person Shooter Game. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 338–349. DOI : <http://dx.doi.org/10.1145/2967934.2968101>
- [76] Leen Haerens, Nathalie Aelterman, Maarten Vansteenkiste, Bart Soenens, and Stijn Van Petegem. 2015. Do Perceived Autonomy-Supportive and Controlling Teaching Relate to Physical Education Students' Motivational Experiences Through Unique Pathways? Distinguishing Between the Bright and Dark Side of Motivation. *Psychology of Sport and Exercise* 16, 3 (2015), 26–36.
- [77] * Joshua V. Hall, Peta A. Wyeth, and Daniel Johnson. 2014. Instructional Objectives to Core-gameplay: A Serious Game Design Technique. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 121–130. DOI : <http://dx.doi.org/10.1145/2658537.2658696>
- [78] * Stuart Hallifax, Audrey Serna, Jean-Charles Marty, Guillaume Lavoué, and Elise Lavoué. 2019. Factors to Consider for Tailored Gamification. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 559–572. DOI : <http://dx.doi.org/10.1145/3311350.3347167>
- [79] Juho Hamari and Jonna Koivisto. 2014. Measuring flow in gamification: Dispositional flow scale-2. *Computers in Human Behavior* 40 (2014), 133–143. DOI : <http://dx.doi.org/10.1016/j.chb.2014.07.048>
- [80] Erik Harpstead, Thomas Zimmermann, Nachiappan Nagappan, Jose J. Guajardo, Ryan Cooper, Tyson Solberg, and Dan Greenawalt. 2015. What Drives People: Creating Engagement Profiles of Players from Game Log Data. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. ACM, 369–379.
- [81] * John Harris and Mark Hancock. 2019. To Asymmetry and Beyond!: Improving Social Connectedness by Increasing Designed Interdependence in Cooperative Play. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 9, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300239>
- [82] * Casper Hartevelde and Steven C. Sutherland. 2015. The Goal of Scoring: Exploring the Role of Game Performance in Educational Games. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2235–2244. DOI : <http://dx.doi.org/10.1145/2702123.2702606>
- [83] * Kieran Hicks, Kathrin Gerling, Patrick Dickinson, and Vero Vanden Abeele. 2019. Juicy Game Design: Understanding the Impact of Visual Embellishments on Player Experience. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 185–197. DOI : <http://dx.doi.org/10.1145/3311350.3347171>

- [84] * Kieran Hicks, Kathrin Gerling, Ben Kirman, Conor Linehan, and Patrick Dickinson. 2015. Exploring Twitter As a Game Platform; Strategies and Opportunities for Microblogging-based Games. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*. ACM, New York, NY, USA, 151–161. DOI : <http://dx.doi.org/10.1145/2793107.2793119>
- [85] Celia Hodent. 2017. *The Gamer's Brain: How Neuroscience and UX Can Impact Video Game Design*. CRC Press.
- [86] * Christos Ioannou, Patrick Archard, Eamonn O'Neill, and Christof Lutteroth. 2019. Virtual Performance Augmentation in an Immersive Jump & Run Exergame. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 158, 15 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300388>
- [87] * Colby Johanson, Carl Gutwin, Jason T. Bowey, and Regan L. Mandryk. 2019. Press Pause when you Play: Comparing Spaced Practice Intervals for Skill Development in Games. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 169–184. DOI : <http://dx.doi.org/10.1145/3311350.3347195>
- [88] * Colby Johanson and Regan L. Mandryk. 2016. Scaffolding Player Location Awareness Through Audio Cues in First-Person Shooters. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3450–3461. DOI : <http://dx.doi.org/10.1145/2858036.2858172>
- [89] * Daniel Johnson, Lennart E. Nacke, and Peta Wyeth. 2015. All About That Base: Differing Player Experiences in Video Game Genres and the Unique Case of MOBA Games. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2265–2274. DOI : <http://dx.doi.org/10.1145/2702123.2702447>
- [90] * Daniel Johnson, Christopher Watling, John Gardner, and Lennart E. Nacke. 2014. The Edge of Glory: The Relationship Between Metacritic Scores and Player Experience. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 141–150. DOI : <http://dx.doi.org/10.1145/2658537.2658694>
- [91] * Daniel Johnson, Peta Wyeth, Madison Clark, and Christopher Watling. 2015. Cooperative Game Play with Avatars and Agents: Differences in Brain Activity and the Experience of Play. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 3721–3730. DOI : <http://dx.doi.org/10.1145/2702123.2702468>
- [92] Daniel Johnson and John Gardner. 2010. Personality, Motivation and Video Games. In *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction*. ACM, 276–279. DOI : <http://dx.doi.org/10.1145/1952222.1952281>
- [93] Daniel Johnson, M John Gardner, and Ryan Perry. 2018. Validation of two game experience scales: the player experience of need satisfaction (PENS) and game experience questionnaire (GEQ). *International Journal of Human-Computer Studies* 118 (2018), 38–46. DOI : <http://dx.doi.org/10.1016/j.ijhcs.2018.05.003>
- [94] * Raine Kajastila, Leo Holsti, and Perttu Hämäläinen. 2016. The Augmented Climbing Wall: High-Exertion Proximity Interaction on a Wall-Sized Interactive Surface. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 758–769. DOI : <http://dx.doi.org/10.1145/2858036.2858450>
- [95] * Dominic Kao and D. Fox Harrell. 2018. The Effects of Badges and Avatar Identification on Play and Making in Educational Games. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 600, 19 pages. DOI : <http://dx.doi.org/10.1145/3173574.3174174>
- [96] * Maximus D. Kaos, Ryan E. Rhodes, Perttu Hämäläinen, and T.C. Nicholas Graham. 2019. Social Play in an Exergame: How the Need to Belong Predicts Adherence. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 430, 13 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300660>
- [97] * Dennis L. Kappen, Pejman Mirza-Babaei, and Lennart E. Nacke. 2017. Gamification Through the Application of Motivational Affordances for Physical Activity Technology. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 5–18. DOI : <http://dx.doi.org/10.1145/3116595.3116604>
- [98] * Madison Klarkowski, Daniel Johnson, Peta Wyeth, Mitchell McEwan, Cody Phillips, and Simon Smith. 2016. Operationalising and Evaluating Sub-Optimal and Optimal Play Experiences Through Challenge-Skill Manipulation. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 5583–5594. DOI : <http://dx.doi.org/10.1145/2858036.2858563>
- [99] Jeppe Komulainen, Jari Takatalo, Miikka Lehtonen, and Göte Nyman. 2008. Psychologically Structured Approach to User Experience in Games. In *Proceedings of the 5th Nordic Conference on Human-computer Interaction: Building Bridges*

(NordiCHI '08). ACM, New York, NY, USA, 487–490. DOI : <http://dx.doi.org/10.1145/1463160.1463226>

- [100] * Yubo Kou, Yao Li, Xinning Gui, and Eli Suzuki-Gill. 2018. Playing with Streakiness in Online Games: How Players Perceive and React to Winning and Losing Streaks in League of Legends. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 578, 14 pages. DOI : <http://dx.doi.org/10.1145/3173574.3174152>
- [101] * Andrey Krekhov, Sebastian Cmentowski, Katharina Emmerich, and Jens Krüger. 2019. Beyond Human: Animals as an Escape from Stereotype Avatars in Virtual Reality Games. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 439–451. DOI : <http://dx.doi.org/10.1145/3311350.3347172>
- [102] * Andrey Krekhov, Katharina Emmerich, Philipp Bergmann, Sebastian Cmentowski, and Jens Krüger. 2017. Self-Transforming Controllers for Virtual Reality First Person Shooters. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 517–529. DOI : <http://dx.doi.org/10.1145/3116595.3116615>
- [103] * Shringi Kumari, Sebastian Deterding, and Jonathan Freeman. 2019. The Role of Uncertainty in Moment-to-Moment Player Motivation: A Grounded Theory. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 351–363. DOI : <http://dx.doi.org/10.1145/3311350.3347148>
- [104] Marc-André K Lafrenière, Jérémie Verner-Filion, and Robert J Vallerand. 2012. Development and validation of the Gaming Motivation Scale (GAMS). *Personality and individual differences* 53, 7 (2012), 827–831. DOI : <http://dx.doi.org/10.1016/j.paid.2012.06.013>
- [105] Carine Lallemand, Vincent Koenig, and Guillaume Gronier. 2014. How Relevant is an Expert Evaluation of User Experience Based on a Psychological Needs-driven Approach?. In *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational (NordiCHI '14)*. ACM, New York, NY, USA, 11–20. DOI : <http://dx.doi.org/10.1145/2639189.2639214>
- [106] Effie L.-C. Law, Florian Brühlmann, and Elisa D. Mekler. 2018. Systematic Review and Validation of the Game Experience Questionnaire (GEQ) – Implications for Citation and Reporting Practice. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play*. ACM, 257–270. DOI : <http://dx.doi.org/10.1145/3242671.3242683>
- [107] Lisa Legault and Catherine E. Amiot. 2014. The Role of Autonomy in Intergroup Processes: Toward an Integration of Self-Determination Theory and Intergroup Approaches. In *Human Motivation and Interpersonal Relationships: Theory, Research, and Applications*. Springer, Dordrecht, Netherlands, 159–190.
- [108] * Lauri Lehtonen, Maximus D. Kaos, Raine Kajastila, Leo Holsti, Janne Karsisto, Sami Pekkola, Joni Vähämäki, Lassi Vapaakallio, and Perttu Hämäläinen. 2019. Movement Empowerment in a Multiplayer Mixed-Reality Trampoline Game. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 19–29. DOI : <http://dx.doi.org/10.1145/3311350.3347181>
- [109] * Pascal Lessel, Maximilian Altmeyer, and Nicolas Brauner. 2019a. Crowdjump: Investigating A Player-Driven Platform Game. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 149–159. DOI : <http://dx.doi.org/10.1145/3311350.3347168>
- [110] * Pascal Lessel, Maximilian Altmeyer, Lea Verena Schmeer, and Antonio Krüger. 2019b. “Enable or Disable Gamification?” Analyzing the Impact of Choice in a Gamified Image Tagging Task. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 150, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300380>
- [111] * Jingya Li, Erik D. van der Spek, Jun Hu, and Loe Feijs. 2019. Turning Your Book into a Game: Improving Motivation through Tangible Interaction and Diegetic Feedback in an AR Mathematics Game for Children. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 73–85. DOI : <http://dx.doi.org/10.1145/3311350.3347174>
- [112] * Derek Lomas, Kishan Patel, Jodi L. Forlizzi, and Kenneth R. Koedinger. 2013. Optimizing Challenge in an Educational Game Using Large-scale Design Experiments. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. ACM, New York, NY, USA, 89–98. DOI : <http://dx.doi.org/10.1145/2470654.2470668>
- [113] * J. Derek Lomas, Kenneth Koedinger, Nirmal Patel, Sharan Shodhan, Nikhil Poonwala, and Jodi L. Forlizzi. 2017. Is Difficulty Overrated?: The Effects of Choice, Novelty and Suspense on Intrinsic Motivation in Educational Games. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 1028–1039. DOI : <http://dx.doi.org/10.1145/3025453.3025638>
- [114] * Michael Long and Carl Gutwin. 2018. Characterizing and Modeling the Effects of Local Latency on Game Performance and Experience. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 285–297. DOI : <http://dx.doi.org/10.1145/3242671.3242678>

- [115] * Michael Long and Carl Gutwin. 2019. Effects of Local Latency on Game Pointing Devices and Game Pointing Tasks. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 208, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300438>
- [116] Kevin Loughrey and Daire Broin. 2018. Are We Having Fun Yet? Misapplying Motivation to Gamification. In *2018 IEEE Games, Entertainment, Media Conference (GEM)*. IEEE, 1–9. DOI : <http://dx.doi.org/10.1109/GEM.2018.8516535>
- [117] Thomas Malone. 1981. What Makes Computer Games Fun?. In *Proceedings of the Joint Conference on Easier and More Productive Use of Computer Systems. (Part - II): Human Interface and the User Interface - Volume 1981 (CHI '81)*. ACM, New York, NY, USA, 143–. DOI : <http://dx.doi.org/10.1145/800276.810990>
- [118] David Markland and David K Ingledew. 1997. The measurement of exercise motives: Factorial validity and invariance across gender of a revised Exercise Motivations Inventory. *British Journal of Health Psychology* 2, 4 (1997), 361–376. DOI : <http://dx.doi.org/10.1111/j.2044-8287.1997.tb00549>
- [119] * Elena Márquez Segura, Annika Waern, Luis Márquez Segura, and David López Recio. 2016. Playification: The PhySeEar Case. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 376–388. DOI : <http://dx.doi.org/10.1145/2967934.2968099>
- [120] Joe Marshall and Conor Linehan. 2017. Misrepresentation of Health Research in Exertion Games Literature. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 4899–4910. DOI : <http://dx.doi.org/10.1145/3025453.3025691>
- [121] Joe Marshall, Conor Linehan, Jocelyn Spence, and Stefan Rennick Egglestone. 2017. Throwaway Citation of Prior Work Creates Risk of Bad HCI Research. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '17)*. ACM, New York, NY, USA, 827–836. DOI : <http://dx.doi.org/10.1145/3027063.3052751>
- [122] Edward McAuley, Terry Duncan, and Vance V. Tammen. 1989. Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis. *Research Quarterly for Exercise and Sport* 60, 1 (1989), 48–58.
- [123] * Mitchell W. McEwan, Alethea L. Blackler, Daniel M. Johnson, and Peta A. Wyeth. 2014. Natural Mapping and Intuitive Interaction in Videogames. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 191–200. DOI : <http://dx.doi.org/10.1145/2658537.2658541>
- [124] Elisa D. Mekler, Julia Ayumi Bopp, Alexandre N. Tuch, and Klaus Opwis. 2014. A Systematic Review of Quantitative Studies on the Enjoyment of Digital Entertainment Games. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 927–936. DOI : <http://dx.doi.org/10.1145/2556288.2557078>
- [125] Elisa D Mekler, Florian Brühlmann, Alexandre N Tuch, and Klaus Opwis. 2017. Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior* 71 (2017), 525–534. DOI : <http://dx.doi.org/10.1016/j.chb.2015.08.048>
- [126] David Melhart, Ahmad Azadvar, Alessandro Canossa, Antonios Liapis, and Georgios N Yannakakis. 2019. Your Gameplay Says it All: Modelling Motivation in Tom Clancy’s The Division. *arXiv preprint arXiv:1902.00040* (2019).
- [127] * Ann Morrison, Antti Oulasvirta, Peter Peltonen, Saija Lemmela, Giulio Jacucci, Gerhard Reitmayr, Jaana Näsänen, and Antti Juustila. 2009. Like Bees Around the Hive: A Comparative Study of a Mobile Augmented Reality Map. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*. ACM, New York, NY, USA, 1889–1898. DOI : <http://dx.doi.org/10.1145/1518701.1518991>
- [128] Jeanne Nakamura and Mihaly Csikszentmihalyi. 2014. The concept of flow. In *Flow and the foundations of positive psychology*. Springer, 239–263. DOI : http://dx.doi.org/10.1007/978-94-017-9088-8_16
- [129] Joyce LD Neys, Jeroen Jansz, and Ed SH Tan. 2014. Exploring persistence in gaming: The role of self-determination and social identity. *Computers in Human Behavior* 37 (2014), 196–209. DOI : <http://dx.doi.org/10.1016/j.chb.2014.04.047>
- [130] * Rita Orji, Gustavo F. Tondello, and Lennart E. Nacke. 2018. Personalizing Persuasive Strategies in Gameful Systems to Gamification User Types. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 435, 14 pages. DOI : <http://dx.doi.org/10.1145/3173574.3174009>
- [131] Pierre-Yves Oudeyer and Frederic Kaplan. 2009. What is intrinsic motivation? A typology of computational approaches. *Frontiers in Neurobotics* 1 (2009), 6. DOI : <http://dx.doi.org/10.3389/neuro.12.006.2007>
- [132] Antti Oulasvirta and Kasper Hornbæk. 2016. HCI Research As Problem-Solving. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 4956–4967. DOI : <http://dx.doi.org/10.1145/2858036.2858283>

- [133] * Maria V. Palacin-Silva, Antti Knutas, Maria Angela Ferrario, Jari Porras, Jouni Ikonen, and Chandara Chea. 2018. The Role of Gamification in Participatory Environmental Sensing: A Study In the Wild. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 221, 13 pages. DOI: <http://dx.doi.org/10.1145/3173574.3173795>
- [134] Luc G Pelletier, Michelle S Fortier, Robert J Vallerand, and Nathalie M Briere. 2001. Associations Among Perceived Autonomy Support, Forms of Self-Regulation, and Persistence: A Prospective Study. *Motivation and Emotion* 25, 4 (2001), 279–306.
- [135] Wei Peng, Jih-Hsuan Lin, Karin A Pfeiffer, and Brian Winn. 2012. Need satisfaction supportive game features as motivational determinants: An experimental study of a self-determination theory guided exergame. *Media Psychology* 15, 2 (2012), 175–196. DOI: <http://dx.doi.org/15213269.2012.673850>
- [136] Dorian Peters, Rafael A Calvo, and Richard M Ryan. 2018. Designing for motivation, engagement and wellbeing in digital experience. *Frontiers in psychology* 9 (2018), 797. DOI: <http://dx.doi.org/10.3389/fpsyg.2018.00797>
- [137] * Serge Petralito, Florian Brühlmann, Glenna Iten, Elisa D. Mekler, and Klaus Opwis. 2017. A Good Reason to Die: How Avatar Death and High Challenges Enable Positive Experiences. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 5087–5097. DOI: <http://dx.doi.org/10.1145/3025453.3026047>
- [138] * Johannes Pfau, Jan David Smeddinck, and Rainer Malaka. 2018. Towards Deep Player Behavior Models in MMORPGs. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 381–392. DOI: <http://dx.doi.org/10.1145/3242671.3242706>
- [139] * Cody Phillips, Daniel Johnson, Madison Klarkowski, Melanie Jade White, and Leanne Hides. 2018. The Impact of Rewards and Trait Reward Responsiveness on Player Motivation. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 393–404. DOI: <http://dx.doi.org/10.1145/3242671.3242713>
- [140] * Clément Pillias, Raphaël Robert-Bouchard, and Guillaume Levieux. 2014. Designing Tangible Video Games: Lessons Learned from the Sifteo Cubes. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 3163–3166. DOI: <http://dx.doi.org/10.1145/2556288.2556991>
- [141] * Susanne Poeller, Max V. Birk, Nicola Baumann, and Regan L. Mandryk. 2018. Let Me Be Implicit: Using Motive Disposition Theory to Predict and Explain Behaviour in Digital Games. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 190, 15 pages. DOI: <http://dx.doi.org/10.1145/3173574.3173764>
- [142] * Lev Poretski, Ofer Arazy, Joel Lanir, Shalev Shahar, and Oded Nov. 2019. Virtual Objects in the Physical World: Relatedness and Psychological Ownership in Augmented Reality. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 691, 13 pages. DOI: <http://dx.doi.org/10.1145/3290605.3300921>
- [143] Andrew K Przybylski, Edward L Deci, C Scott Rigby, and Richard M Ryan. 2014. Competence-Impeding Electronic Games and Players' Aggressive Feelings, Thoughts, and Behaviors. *Journal of Personality and Social Psychology* 106, 3 (2014), 441–457.
- [144] Andrew K. Przybylski, C. Scott Rigby, and Richard M. Ryan. 2010. A Motivational Model of Video Game Engagement. *Review of General Psychology* 14, 2 (2010), 154–166.
- [145] Andrew K. Przybylski and Netta Weinstein. 2019. Investigating the Motivational and Psychosocial Dynamics of Dysregulated Gaming: Evidence From a Preregistered Cohort Study. *Clinical Psychological Science* (2019), 1–9.
- [146] * Anke V. Reinschluessel and Regan L. Mandryk. 2016. Using Positive or Negative Reinforcement in Neurofeedback Games for Training Self-Regulation. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 186–198. DOI: <http://dx.doi.org/10.1145/2967934.2968085>
- [147] * Chad Richards, Craig W. Thompson, and Nicholas Graham. 2014. Beyond Designing for Motivation: The Importance of Context in Gamification. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 217–226. DOI: <http://dx.doi.org/10.1145/2658537.2658683>
- [148] Caroline R Richardson, Lorraine R Buis, Adrienne W Janney, David E Goodrich, Ananda Sen, Michael L Hess, Kathleen S Mehari, Laurie A Fortlage, Paul J Resnick, Brian J Zikmund-Fisher, and others. 2010. An online community improves adherence in an internet-mediated walking program. Part 1: results of a randomized controlled trial. *Journal of medical Internet research* 12, 4 (2010), e71. DOI: <http://dx.doi.org/10.2196/jmir.1338>
- [149] C Scott Rigby. 2015. Gamification and motivation. *The gameful world: Approaches, issues, applications* (2015), 113–138.

- [150] C. Scott Rigby and Richard M. Ryan. 2007. The Player Experience of Need Satisfaction (PENS): An Applied Model and Methodology for Understanding Key Components of the Player Experience. White Paper. (2007). Immersyve, Inc., Florida, USA. Retrieved 26 August, 2019 from <http://immersyve.com/download/pens-white-paper/?wpdmdl=8283>.
- [151] C. Scott Rigby and Richard M. Ryan. 2017. *Time Well-Spent? Motivation for Entertainment Media and Its Eudaimonic Aspects Through the Lens of Self-Determination Theory*. Routledge, New York, USA, 34–48.
- [152] Scott Rigby and Richard M. Ryan. 2011. *Glued to Games: How Video Games Draw Us In and Hold Us Spellbound*. ABC-CLIO, Santa Barbara, CA.
- [153] Yvonne Rogers. 2012. HCI theory: classical, modern, and contemporary. *Synthesis lectures on human-centered informatics* 5, 2 (2012), 1–129.
- [154] * Shaghayegh Roohi, Jari Takatalo, Christian Guckelsberger, and Perttu Hämäläinen. 2018. Review of Intrinsic Motivation in Simulation-based Game Testing. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 347, 13 pages. DOI : <http://dx.doi.org/10.1145/3173574.3173921>
- [155] * John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2015. Pass the Ball: Enforced Turn-Taking in Activity Tracking. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2417–2426. DOI : <http://dx.doi.org/10.1145/2702123.2702577>
- [156] Richard M. Ryan, Randall R. Curren, and Edward L. Deci. 2013. *What Humans Need: Flourishing in Aristotelian Philosophy and Self-Determination Theory*. American Psychological Association, Washington, DC, 57–75. DOI : <http://dx.doi.org/10.1037/14092-004>
- [157] Richard M Ryan and Edward L Deci. 2000. Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology* 25, 1 (2000), 54–67. DOI : <http://dx.doi.org/10.1006/ceps.1999.1020>
- [158] Richard M Ryan and Edward L Deci. 2017a. Basic Psychological Needs Theory: Satisfaction and Frustration of Autonomy, Competence, and Relatedness in Relation to Psychological Wellness and Full Functioning. In *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications, 239–271.
- [159] Richard M. Ryan and Edward L. Deci. 2017b. Goal Contents Theory: Aspirations, Life Goals, and Their Varied Consequences. In *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford, New York, USA, 272–292.
- [160] Richard M Ryan and Edward L Deci. 2017c. Motivation and Need Satisfaction in Video Games and Virtual Environments. In *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications, 508–531.
- [161] Richard M. Ryan and Edward L. Deci. 2017d. Organismic Integration Theory: Internalisation and the Differentiation of Extrinsic Motivation. In *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford, New York, USA, 179–215.
- [162] Richard M. Ryan and Edward L. Deci. 2017e. Relationships Motivation Theory: The Self in Close Relationships. In *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford, New York, USA, 293–316.
- [163] Richard M Ryan and Edward L Deci. 2017f. *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.
- [164] Richard M Ryan and Edward L Deci. 2017g. Self-Determination Theory An Introduction and Overview. In *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications, 3–29.
- [165] Richard M Ryan and Edward L Deci. 2019. Brick by Brick: The Origins, Development, and Future of Self-Determination Theory. In *Advances in Motivation Science*. Elsevier, 111–156.
- [166] Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. 2006. The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion* 30, 4 (2006), 344–360. DOI : <http://dx.doi.org/10.1007/s11031-006-9051-8>
- [167] Michael Sailer, Jan Ulrich Hense, Sarah Katharina Mayr, and Heinz Mandl. 2017. How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior* 69 (2017), 371–380. DOI : <http://dx.doi.org/10.1016/j.chb.2016.12.033>
- [168] * Anurag Sarkar and Seth Cooper. 2019. Transforming Game Difficulty Curves Using Function Composition. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 551, 7 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300781>
- [169] Katie Seaborn and Deborah I Fels. 2015. Gamification in theory and action: A survey. *International Journal of human-computer studies* 74 (2015), 14–31. DOI : <http://dx.doi.org/10.1016/j.ijhcs.2014.09.006>
- [170] * Orit Shaer, Lauren Westendorf, Nicholas A. Knouf, and Claudia Pederson. 2017. Understanding Gaming Perceptions and Experiences in a Women’s College Community. In *Proceedings of the 2017 CHI*

Conference on Human Factors in Computing Systems (CHI '17). ACM, New York, NY, USA, 1544–1557. DOI: <http://dx.doi.org/10.1145/3025453.3025623>

- [171] Kennon M Sheldon. 2011. Integrating behavioral-motive and experiential-requirement perspectives on psychological needs: A two process model. *Psychological review* 118, 4 (2011), 552. DOI: <http://dx.doi.org/10.1037/a0024758>
- [172] Kennon M. Sheldon and Alexander Gunz. 2009. Psychological Needs as Basic Motives, Not Just Experiential Requirements. *Journal of Personality* 77, 5 (2009), 1467–1492. DOI: <http://dx.doi.org/10.1111/j.1467-6494.2009.00589.x>
- [173] Kennon M. Sheldon and Jonathan C. Hilpert. 2012. The Balanced Measure of Psychological Needs (BMPN) Scale: An Alternative Domain General Measure of Need Satisfaction. *Motivation and Emotion* 36, 4 (2012), 439–451.
- [174] * Jan D. Smeddinck, Regan L. Mandryk, Max V. Birk, Kathrin M. Gerling, Dietrich Barsilowski, and Rainer Malaka. 2016. How to Present Game Difficulty Choices?: Exploring the Impact on Player Experience. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 5595–5607. DOI: <http://dx.doi.org/10.1145/2858036.2858574>
- [175] * Milad Soroush, Mark Hancock, and Vanessa K. Bohns. 2018. Investigating Game Mechanics That Target Players' Self-Control While Maintaining Engagement. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 489–502. DOI: <http://dx.doi.org/10.1145/3242671.3242698>
- [176] * Fabius Steinberger, Ronald Schroeter, Marcus Foth, and Daniel Johnson. 2017. Designing Gamified Applications That Make Safe Driving More Engaging. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 2826–2839. DOI: <http://dx.doi.org/10.1145/3025453.3025511>
- [177] Penelope Sweetser and Peta Wyeth. 2005. GameFlow: A Model for Evaluating Player Enjoyment in Games. *Comput. Entertain.* 3, 3 (July 2005), 3–3. DOI: <http://dx.doi.org/10.1145/1077246.1077253>
- [178] Ron Tamborini, Nicholas David Bowman, Allison Eden, Matthew Grizzard, and Ashley Organ. 2010. Defining Media Enjoyment as the Satisfaction of Intrinsic Needs. *Journal of Communication* 60, 4 (2010), 758–777.
- [179] * Gustavo F. Tondello and Lennart E. Nacke. 2019. Player Characteristics and Video Game Preferences. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 365–378. DOI: <http://dx.doi.org/10.1145/3311350.3347185>
- [180] * Gustavo F. Tondello, Rina R. Wehbe, Lisa Diamond, Marc Busch, Andrzej Marczewski, and Lennart E. Nacke. 2016. The Gamification User Types Hexad Scale. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 229–243. DOI: <http://dx.doi.org/10.1145/2967934.2968082>
- [181] * Gustavo F. Tondello, Rina R. Wehbe, Rita Orji, Giovanni Ribeiro, and Lennart E. Nacke. 2017. A Framework and Taxonomy of Videogame Playing Preferences. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 329–340. DOI: <http://dx.doi.org/10.1145/3116595.3116629>
- [182] * April Tyack, Peta Wyeth, and Daniel Johnson. 2016. The Appeal of MOBA Games: What Makes People Start, Stay, and Stop. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16)*. ACM, New York, NY, USA, 313–325. DOI: <http://dx.doi.org/10.1145/2967934.2968098>
- [183] April Tyack and Peta Wyeth. 2017. Exploring Relatedness in Single-Player Video Game Play. In *Proceedings of the 29th Australian Conference on Computer-Human Interaction*. ACM, 422–427.
- [184] April Tyack, Peta Wyeth, and Daniel Johnson. 2020. Restorative Play: Videogames Improve Player Wellbeing After a Need-Frustrating Event. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM. DOI: <http://dx.doi.org/10.1145/3313831.3376332>
- [185] Robert J. Vallerand. 1997. Toward a Hierarchical Model of Intrinsic and Extrinsic Motivation. *Advances in Experimental Social Psychology* 29 (1997), 271–360.
- [186] Robert J Vallerand, Luc G Pelletier, and Richard Koestner. 2008. Reflections on self-determination theory. *Canadian Psychology/Psychologie canadienne* 49, 3 (2008), 257. DOI: <http://dx.doi.org/10.1037/a0012804>
- [187] Rob van Roy and Bieke Zaman. 2017. Why gamification fails in education and how to make it successful: introducing nine gamification heuristics based on self-determination theory. In *Serious Games and edutainment applications*. Springer, 485–509. DOI: http://dx.doi.org/10.1007/978-3-319-51645-5_22
- [188] * Vero Vanden Abeele, Jan Wouters, Pol Ghesquière, Ann Goeleven, and Luc Geurts. 2015. Game-based Assessment of Psycho-acoustic Thresholds: Not All Games Are Equal!. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*. ACM, New York, NY, USA, 331–341. DOI: <http://dx.doi.org/10.1145/2793107.2793132>

- [189] Jason VandenBerghe. 2014. Engines of Play: How Player Motivation Changes over Time. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 476–476. DOI : <http://dx.doi.org/10.1145/2658537.2677953>
- [190] Maarten Vansteenkiste, Christopher P Niemic, and Bart Soenens. 2010. The development of the five mini-theories of self-determination theory: An historical overview, emerging trends, and future directions. In *The decade ahead: Theoretical perspectives on motivation and achievement*. Emerald Group Publishing Limited, 105–165. DOI : [http://dx.doi.org/10.1108/S0749-7423\(2010\)000016A007](http://dx.doi.org/10.1108/S0749-7423(2010)000016A007)
- [191] Maarten Vansteenkiste and Kennon M Sheldon. 2006. There's nothing more practical than a good theory: Integrating motivational interviewing and self-determination theory. *British journal of clinical psychology* 45, 1 (2006), 63–82. DOI : <http://dx.doi.org/10.1348/014466505X34192>
- [192] * Kellie Vella, Daniel Johnson, and Leanne Hides. 2015. Playing Alone, Playing With Others: Differences in Player Experience and Indicators of Wellbeing. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*. ACM, New York, NY, USA, 3–12. DOI : <http://dx.doi.org/10.1145/2793107.2793118>
- [193] * Kellie Vella, Christopher James Koren, and Daniel Johnson. 2017. The Impact of Agency and Familiarity in Cooperative Multiplayer Games. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '17)*. ACM, New York, NY, USA, 423–434. DOI : <http://dx.doi.org/10.1145/3116595.3116622>
- [194] * Kellie Vella, Nikki Peever, Madison Klarkowski, Bernd Ploderer, Jo Mitchell, and Daniel Johnson. 2018. Using Applied Games to Engage mHealth Users: A Case Study of MindMax. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18)*. ACM, New York, NY, USA, 511–522. DOI : <http://dx.doi.org/10.1145/3242671.3242686>
- [195] Raphael Velt, Steve Benford, and Stuart Reeves. 2017. A Survey of the Trajectories Conceptual Framework: Investigating Theory Use in HCI. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 2091–2105. DOI : <http://dx.doi.org/10.1145/3025453.3026022>
- [196] * Rodrigo Vicencio-Moreira, Regan L. Mandryk, and Carl Gutwin. 2015. Now You Can Compete With Anyone: Balancing Players of Different Skill Levels in a First-Person Shooter Game. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2255–2264. DOI : <http://dx.doi.org/10.1145/2702123.2702242>
- [197] * Benjamin Walther-Franks, Jan Smeddinck, Peter Szmidi, Andrei Haidu, Michael Beetz, and Rainer Malaka. 2015. Robots, Pancakes, and Computer Games: Designing Serious Games for Robot Imitation Learning. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 3623–3632. DOI : <http://dx.doi.org/10.1145/2702123.2702552>
- [198] Xuequn Wang, Christoph Schneider, and Joseph S Valacich. 2012. Fine-tuning group collaboration environments: how differences in general causality orientation and performance targets shape interaction and performance. In *2012 45th Hawaii International Conference on System Sciences*. IEEE, 553–561. DOI : <http://dx.doi.org/10.1109/HICSS.2012.281>
- [199] David A Whetten. 1989. What constitutes a theoretical contribution? *Academy of management review* 14, 4 (1989), 490–495.
- [200] Geoffrey C Williams, Virginia M Grow, Zachary R Freedman, Richard M Ryan, and Edward L Deci. 1996. Motivational Predictors of Weight Loss and Weight-Loss Maintenance. *Journal of Personality and Social Psychology* 70, 1 (1996), 115–126.
- [201] * Blake Williford, Matthew Runyon, Josh Cherian, Wayne Li, Julie Linsey, and Tracy Hammond. 2019. A Framework for Motivating Sketching Practice with Sketch-based Gameplay. In *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19)*. ACM, 533–544. DOI : <http://dx.doi.org/10.1145/3311350.3347175>
- [202] * Jason Wuertz, Max V. Birk, and Scott Bateman. 2019. Healthy Lies: The Effects of Misrepresenting Player Health Data on Experience, Behavior, and Performance. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 319, 12 pages. DOI : <http://dx.doi.org/10.1145/3290605.3300549>

* Reference included in literature review.