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Beyond Intrinsic: Using the Quality of Extrinsic Motivation to Understand Effort in Virtual Rehabilitation and Exergames

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CCS Concepts: • **Human-centered computing → HCI theory, concepts and models**; • **Applied computing → Psychology**.

Additional Key Words and Phrases: Intrinsic Motivation, Extrinsic Motivation, Self-Determination Theory, Virtual Reality, Physical Therapy, Older Adults

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1 INTRODUCTION

Active Video Games (AVG) or Exertion Games (exergames) have long been suggested as a method to encourage physical activity [14, 23] and sustain motivation in rehabilitation programs, where adherence is frequently low [19, 21]. Researchers have therefore investigated how computer-mediated technologies can foster patients' feelings of enjoyment and satisfaction while undergoing tedious (or even painful) exercises. This has led to the emergence of novel uses of technology, such as virtual reality (VR), and to new interdisciplinary fields composed of researchers from diverse domains who jointly seek to overcome the related challenges with motivation in rehabilitation and therapy [3, 15], with researchers frequently relying on the self-determination theory (SDT) when establishing design requirements [27, 30].

SDT is a broad theory on human motivation, which seeks to explain why individuals decide to engage, participate, and exert effort in activities. Although SDT has been applied to diverse domains such as education, work, parenting, clinical practice, health and Human-Computer Interaction (HCI) [14, 21, 31, 32], the application to HCI has not been without some inconsistencies and misconceptions [32]. Research on the effects of HCI and computer-mediated technology for physical therapy and health has generally emphasized the importance of intrinsic (versus extrinsic) motivation for outcomes such as adherence. Although SDT is consistent with this claim, it provides a more refined perspective on motivation by distinguishing between different types of extrinsic motivation that fall along the continuum of increasing self-endorsement (see Fig. 1) [6, 26]. First, external regulation is apparent when individuals engage in a certain activity to avoid threats and criticism or to obtain social approval. Whereas external regulation is characterized by external pressure, introjected regulation is typified by pressure from within such as the avoidance of feelings of shame and guilt or the attainment of self-esteem and pride. A fuller form of self-endorsement is achieved when individuals pursue an activity because they find this personally relevant and thus display identified regulation. Integrated regulation, the extrinsic motivation type characterized by the highest level of self-endorsement or autonomous motivation, is

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apparent when engagement in the activity is perceived to be congruent with other important life values and interests an individual holds [6].

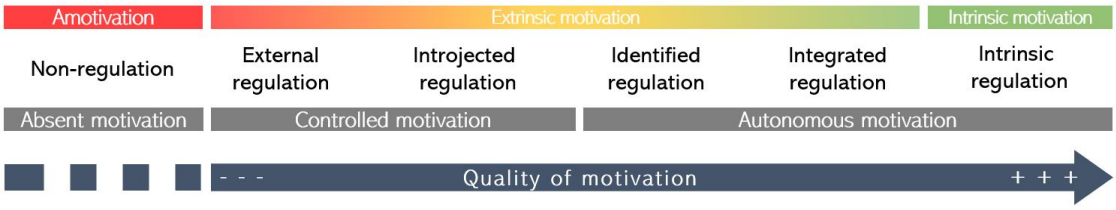

Fig. 1. The self-determination continuum. Adapted from [27]

While SDT researchers are highly interested in the types of motivation that regulate behavior, research within the fields of HCI and virtual rehabilitation has mainly focused on only the intrinsic properties of motivation (e.g., interest and enjoyment). However, intrinsic motivation is only one of the three sub-types of autonomous motivation, all indicating high levels of volition and choice. As autonomous motivation has more consistently been related to a higher quality of performance and experience than controlled motivation [25, 27], we believe HCI-research will benefit from adopting a more refined and comprehensive perspective on motivation, to assure pleasant user experiences. For example, although previous research has posited that factors such as competition [17, 29, 35], high-scores and leaderboards [34], and point scoring [20] can increase one's intrinsic motivation for physical activity, SDT's motivational framework would indicate that such factors are also likely to engender external (e.g., wanting to be better than others) or introjected (e.g., engaging in physical activity to maintain one's self-esteem) motivation [5, 22].

2 THE NEED FOR A NEW INSTRUMENT

One of the most popular SDT-instruments to measure motivation in HCI-studies is the intrinsic motivation inventory (IMI) [2, 4, 7, 8, 10, 11, 13, 21, 33]. However, when IMI is applied within studies that evaluate computer-mediated technology in the fields of physical therapy and rehabilitation, it poses a distinctive problem. Patients often do not experience feelings of interest or enjoyment from the therapy itself, and as a consequence motivation is often low [19, 21]. By relying on the IMI to assess individuals' situational motivation, researchers may incidentally lose valuable insights into how the (human-computer) interaction may be influenced by other types of autonomous motivation.

Moreover, in many cases the IMI is used in controlled laboratory studies to evaluate early prototypes and pilot studies, using a convenient sampling method which may incidentally not represent the population of interest. While this is a sensible way of achieving fast results, it is worth considering whether the choice of measurements is valid in more applied contexts. For example, if undergraduates are used in early studies, results gained from the IMI may reflect that the younger generations has a greater propensity towards games and technology than that of older adults. This challenge of low representativeness in early (laboratory) studies, may also be one of the reasons why some randomized controlled trials (RCT) report a higher dropout rate in the experimental groups, as suggested by a recent systematic review and meta-analysis of various kinds of virtual rehabilitation systems for older adults undergoing physical therapy [12].

The motivational "pull" of video games have previously been thoroughly investigated, which lead to the development of the Player Experience of Need Satisfaction (PENS) instrument [28]. However, while the PENS seeks to survey the

intrinsic psychological needs supported through peoples' engagement in recreational gaming, these scenarios are typically derived from activities that are already interesting to the participants. Arguably, the attitude is different among participants who are introduced to a game concept in a rehabilitation context e.g. during hospital admission. In such a scenario, instilling a sense of volition and enjoyment in otherwise repetitive exercises, through a game experience, can likely lead to a positive shift in the quality of motivation.

Therefore, we argue that the choice of measurement is even more important when exergames and virtual rehabilitation applications are applied to real world contexts, outside laboratory settings, where it **A)** may not be sensible to anticipate the that intrinsic motivation can be invoked, and **B)** may not be broad enough to measure the finer granulates of autonomous motivation.

To this end, we propose an instrument based on the Situational Motivation Scale (SIMS) [9, 24]. The scale (see Table 1) assesses the five different types of motivation (amotivation, external, introjected, identified and intrinsic motivation). While the SIMS asks the situational question: "why are you currently engaged in this?", we decided to ask the post-situation question "Why did you make an effort in this activity?". The 20 items represent potential answers to this question equally corresponding with the different motivational qualities. While the introjected dimension is not part of SIMS, we adapted this subscale (item 3,8,13,18) from another study on motivation in physical education [18].

We consider that the proposed scale could be utilized repeatedly during an intervention involving prolonged use of exergames or virtual rehabilitation in inpatient or outpatient settings, to detect potential changes in motivational quality. The scale has not yet been subjected to dimensionality, reliability nor validation tests since it is still under development. The scale could be re-composed of other items from newer instruments such as the User Motivation Inventory [1] or the Gaming Motivation Scale [16]. By using such scales instead of the IMI, we believe that researchers will most likely reach a better understanding of why participants chose to engage, and make an effort, during therapeutic situations.

3 CONCLUSION

Intrinsic motivation is often regarded as the ideal when developing computer-mediated technology for health and rehabilitation activities in HCI-research. Even though intrinsic motivation is indeed a sustainable and self-rewarding form of motivation, arguably both extrinsic and intrinsic types of motivation are influential factors to an individual's self-regulation that ultimately drives human behavior. Thus, HCI-researchers should embrace instruments that encompasses the wider continuum of motivation rather than just intrinsic motivation alone. To this end we propose a (yet unvalidated) instrument based on the SIMS. We encourage researchers to utilize scales that measures the wider variety of motivational quality during interventions involving older adults and exergames in virtual rehabilitation.

REFERENCES

[1] 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).* Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3173574.3173680

[2] Jon Ram Bruun-Pedersen, Stefania Serafin, and Lise Busk Kofoed. 2016. Motivating elderly to exercise - recreational virtual environment for indoor biking. In *2016 IEEE International Conference on Serious Games and Applications for Health (SeGAH).* 1–9. https://doi.org/10.1109/SeGAH.2016.7586265

[3] Grigore C Burdea. 2003. Virtual rehabilitation–benefits and challenges. *Methods of information in medicine* 42, 05 (2003), 519–523.

[4] Aijse W De Vries, Jaap H Van Dieën, Vero Van Den Abeele, and Sabine MP Verschueren. 2018. Understanding motivations and player experiences of older adults in virtual reality training. *Games for health journal* 7, 6 (2018), 369–376.

[5] Edward L Deci, Gregory Betley, James Kahle, Linda Abrams, and Joseph Porac. 1981. When trying to win: Competition and intrinsic motivation. *Personality and social psychology bulletin* 7, 1 (1981), 79–83.

[6] 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.

[7] Matthew Farrow, Christof Lutteroth, Peter C Rouse, and James LJ Bilzon. 2019. Virtual-reality exergaming improves performance during high-intensity interval training. *European journal of sport science* 19, 6 (2019), 719–727.

[8] Gerard G Fluet, Qinyin Qiu, Jigna Patel, Amanda Cronce, Alma S Merians, and Sergei V Adamovich. 2019. Autonomous use of the home virtual rehabilitation system: a feasibility and pilot study. *Games for health journal* 8, 6 (2019), 432–438.

[9] Frédéric Guay, Robert J Vallerand, and Céline Blanchard. 2000. On the assessment of situational intrinsic and extrinsic motivation: The Situational Motivation Scale (SIMS). *Motivation and emotion* 24, 3 (2000), 175–213.

[10] Emil Rosenlund Høeg, Jon Ram Bruun-Pedersen, Shannon Cheary, Lars Koreska Andersen, Razvan Paisa, Stefania Serafin, and Belinda Lange. 2021. Buddy biking: a user study on social collaboration in a virtual reality exergame for rehabilitation. *Virtual Reality* (27 Jul 2021). https://doi.org/10.1007/s10055-021-00544-z

[11] Emil Rosenlund Høeg, Jon Ram Bruun-Pedersen, and Stefania Serafin. 2021. Virtual Reality-Based High-Intensity Interval Training For Pulmonary Rehabilitation: A Feasibility and Acceptability Study. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*. IEEE, 242–249. https://doi.org/10.1109/VRW52623.2021.00052

[12] Emil Rosenlund Høeg, Tina Myung Povlsen, Jon Ram Bruun-Pedersen, Belinda Lange, Niels Christian Nilsson, Kristian Birkemose Haugaard, Sune Mølgård Faber, Søren Willer Hansen, Charlotte Kira Kimby, and Stefania Serafin. 2021. System immersion in virtual reality-based rehabilitation of motor function in older adults: a systematic review and meta-analysis. *Frontiers in Virtual Reality* 2 (2021), 30.

[13] Hanne Huygelier, Brenda Schraepen, Raymond Van Ee, Vero Vanden Abeele, and Céline R Gillebert. 2019. Acceptance of immersive head-mounted virtual reality in older adults. *Scientific reports* 9, 1 (2019), 1–12.

[14] Daniel Johnson, Sebastian Deterding, Kerri-Ann Kuhn, Aleksandra Staneva, Stoyan Stoyanov, and Leanne Hides. 2016. Gamification for health and wellbeing: A systematic review of the literature. *Internet interventions* 6 (2016), 89–106.

[15] Sebastian T. Koenig, Denise Krch, Belinda S. Lange, and Albert Rizzo. 2019. Virtual reality and rehabilitation. In *Handbook of rehabilitation psychology (3rd ed.)*. American Psychological Association, 521–539. https://doi.org/10.1037/0000129-032

[16] 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. https://doi.org/10.1016/j.paid.2012.06.013

[17] Danielle E. Levac and Heidi Sveistrup. 2014. *Motor Learning and Virtual Reality*. Springer New York, New York, NY, 25–46. https://doi.org/10.1007/978-1-4939-0968-1_3

[18] Chris Lonsdale, Catherine M Sabiston, Ian M Taylor, and Nikos Ntoumanis. 2011. Measuring student motivation for physical education: Examining the psychometric properties of the Perceived Locus of Causality Questionnaire and the Situational Motivation Scale. *Psychology of Sport and Exercise* 12, 3 (2011), 284–292.

[19] Niall Maclean, Pandora Pound, Charles Wolfe, and Anthony Rudd. 2000. Qualitative analysis of stroke patients' motivation for rehabilitation. *BMJ* 321, 7268 (2000), 1051–1054. https://doi.org/10.1136/bmj.321.7268.1051

[20] Wytske Meekes, Emma Kate Stanmore, et al. 2017. Motivational determinants of exergame participation for older people in assisted living facilities: mixed-methods study. *Journal of medical Internet research* 19, 7 (2017), e6841.

[21] Brendan Mouatt, Ashleigh E Smith, Maddison L Mellow, Gaynor Parfitt, Ross T Smith, and Tasha R Stanton. 2020. The Use of Virtual Reality to Influence Motivation, Affect, Enjoyment, and Engagement During Exercise: A Scoping Review. *Frontiers in Virtual Reality* 1 (2020), 39.

[22] Johnmarshall Reeve and Edward L Deci. 1996. Elements of the competitive situation that affect intrinsic motivation. *Personality and Social Psychology Bulletin* 22, 1 (1996), 24–33.

[23] Eduardo Reis, Gabriela Postolache, Luís Teixeira, Patrícia Arriaga, Maria Luísa Lima, and Octavian Postolache. 2019. Exergames for motor rehabilitation in older adults: an umbrella review. *Physical Therapy Reviews* 24, 3-4 (2019), 84–99.

[24] Filipe Rodrigues, Luís Cid, Tânia Faustino, and Diogo Monteiro. 2021. The situational motivation scale in the exercise context: Construct validity, factor structure, and correlational analysis. *Current Psychology* (2021), 1–10.

[25] Guy Roth. 2019. *Beyond the Quantity of Motivation: Quality of Motivation in Self-Determination Theory*. Springer International Publishing, Cham, 39–49. https://doi.org/10.1007/978-3-030-13788-5_3

[26] Richard M Ryan and James P Connell. 1989. Perceived locus of causality and internalization: examining reasons for acting in two domains. *Journal of personality and social psychology* 57, 5 (1989), 749.

[27] Richard M Ryan and Edward L Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist* 55, 1 (2000), 68.

[28] 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.

[29] Hayeon Song, Jihyun Kim, Kelly E Tenzek, and Kwan Min Lee. 2013. The effects of competition and competitiveness upon intrinsic motivation in exergames. *Computers in Human Behavior* 29, 4 (2013), 1702–1708.

[30] 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.

[31] Pedro J Teixeira, Eliana V Carraça, David Markland, Marlene N Silva, and Richard M Ryan. 2012. Exercise, physical activity, and self-determination theory: a systematic review. *International journal of behavioral nutrition and physical activity* 9, 1 (2012), 1–30.

[32] April Tyack and Elisa D Mekler. 2020. Self-determination theory in HCI games research: current uses and open questions. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–22.

[33] Nicolas Wenk, Mirjam V Jordi, Karin A Buetler, and Laura Marchal-Crespo. 2022. Hiding Assistive Robots During Training in Immersive VR Does not Affect Users' Motivation, Presence, Embodiment, Performance, nor Visual Attention. *IEEE Transactions on Neural Systems and Rehabilitation Engineering* (2022), 390–399. https://doi.org/10.1109/TNSRE.2022.3147260

[34] Richard TA Wood, Mark D Griffiths, Darren Chappell, and Mark NO Davies. 2004. The structural characteristics of video games: A psycho-structural analysis. *CyberPsychology & behavior* 7, 1 (2004), 1–10.

[35] Lukas Zimmerli, Mario Jacky, Lars Lünenburger, Robert Riener, and Marc Bolliger. 2013. Increasing patient engagement during virtual reality-based motor rehabilitation. *Archives of physical medicine and rehabilitation* 94, 9 (2013), 1737–1746.

Why did you make an effort in this activity?
1. Because I think that this activity was interesting
2. Because I did it for my own good
3. Because I wanted the other (therapist, fellow participant, researcher) to think that I was good
4. Because I was supposed to do it
5. There may have been good reasons to do this activity, but personally I don't see any
6. Because I think that this activity was pleasant
7. Because I think that this activity was good for me
8. because I would feel guilty if I didn't
9. Because it was something that I had to do
10. I did this activity but I am not sure it is worth it
11. Because this activity was fun
12. By personal decision
13. Because I would feel bad about myself if I didn't
14. Because I didn't have any choice
15. I don't know; I don't see what this activity brings me
16. Because I felt good when doing this activity
17. Because I believe that this activity is important for me
18. Because it bothers me when I don't
19. Because I felt that I have to do it
20. I did this activity, but I am not sure it is a good thing to pursue it

Table 1. Calculate composite scores by averaging the subcategories Intrinsic motivation: 1, 6, 11, 16; Identified regulation: 2, 7, 12, 17; Introjected regulation: 3, 8, 13, 18; External regulation: 4, 9, 14, 19; Amotivation: 5, 10, 15, 20.