This commentary addresses a recent article by Montag et al. (2019) about the relevance of distinguishing between mobile and non-mobile Internet Use Disorder (IUD). In response to the review, we reflect on the clinical relevance of this distinction and, in parallel, we propose some Pavlovian conditioning processes as possible mechanisms underlying different IUDs. We believe that, from a clinical point of view, it is of fundamental importance assessing both specific "forms" of IUDs and the underlying mechanisms that may be shared across different IUDs, like multiple and parallel classes of Pavlovian responses and the influences of Internet cues on Internet-related addictive behaviors that may be influenced by the probability of obtaining Internet rewards.

KEYWORDS
Internet, classical conditioning, reward, gaming, addictive behaviors, cues

INTRODUCTION
The article, “How to overcome taxonomical problems in the study of Internet use disorders and what to do with “smartphone addiction”?" by Montag et al. (2019) describes the relevance of distinguishing between mobile and non-mobile Internet Use Disorders (IUDs) for a better understanding of individuals who (over-)use the Internet, in terms of risk factors and underlying mechanisms. We believe that, from a clinical point of view, it is of fundamental importance assessing both specific "forms" of IUD (i.e., predominantly mobile and predominantly non-mobile IUD) and the underlying mechanisms that may be shared across...
different IUDs, such as Pavlovian associative learning processes, as well as those that may be distinct.

CLINICAL RELEVANCE OF DISTINGUISHING BETWEEN MOBILE AND NON-MOBILE INTERNET USE DISORDER

Although data suggest that similarly to individuals with Substance Use Disorder (SUD), those with IUDs share some important symptoms and comorbidities; e.g., they are more likely to have symptoms associated with depression (e.g., Kitzazawa et al., 2018), stress (e.g., Moretta & Buodo, 2018), and anxiety (e.g., Stavropoulos et al., 2017), loneliness (Moretta & Buodo, 2020), and obsessive-compulsive disorder (Carli et al., 2013), and to be characterized by low inhibitory control in an emotional context (Brand et al., 2019; Moretta, Sarlo, & Buodo, 2019). Additionally, some important differences have been highlighted (Montag, Wegmann, Sariyska, Demetrovics, & Brand, 2019). Some of these differences may be important to assess in clinical contexts given specific negative consequences on individuals’ lives and health care systems. Although considering IUDs as psychopathological conditions is still under discussion, research has identified negative effects of using specific devices (e.g., smartphones) for accessing the Internet in problematic ways. Specifically, studies of smartphone-use-related accidents suggest that using the smartphone is frequently linked to increases driving distraction (Metz, Landau, & Just, 2014), driving mistakes (Young & Salmon, 2012), and the risk of accidents (Nemme & White, 2010). Younger people appear at greater risk than older people (O’Brien, Goodwin, & Foss, 2010; Wagner et al., 2019). While driving, young people with Smartphone Use Disorder (SmUD) exhibit difficulties refraining urge from using their smartphones, and consequentially this may lead to them taking their eyes off the road and their hands off the wheel to touch their screens (Kim, 2013; Luria, 2018).

Although the magnitude of the problem remains unclear, studies of smartphone use during ambulation have generated worrying findings, with smartphone use while walking increasing the risk of injury. Consequently, smartphone-related distracted ambulation has been reported as an increasing the risk of injury. Consequently, smartphone-related worrying findings, with smartphone use while walking studies of smartphone use during ambulation have generated arousal generated by the smartphone task to be a mediator. From a clinical perspective, these studies corroborate the argumentation of Montag et al. (2019) by highlighting the importance of addressing both the specific content/application of IUDs and the IUD forms (i.e., predominantly mobile vs. predominantly non-mobile IUDs), since these seem to be characterized by specific behavioral usage patterns leading to specific potential risks (Ha, Jung, & Shin, 2020).

TOWARD A COMMUNALITY BETWEEN DIFFERENT IUDS: PAVLOVIAN CONDITIONING PROCESSES AND REWARD PROBABILITY

The study and clinical assessment of predominantly mobile and predominantly non-mobile specific IUDs (i.e., ones specifying the content of Internet use/online application) should go in parallel with the investigation of underlying common mechanisms of IUDs (Brand et al., 2019), given some similarities across IUDs and the importance of better conceptualizing and diagnosing IUDs.

A key feature of IUDs and new technologies-related addictive behaviors, which is often not shared with any other addictive behaviors, is the number of available visual (e.g., colored graphical app interfaces; advertisements; emoticons; visual notifications), auditory (e.g., the sounds of notifications, errors, warnings, messages, key press), and tactile cues (e.g., keys, touch screen, device temperature, device covers material) to which many individuals users are frequently exposed. This feature may help answering why some people compulsively search/“surf” online. It has been suggested that conditioned environmental cues may significantly influence online behavior by promoting early attentional bias to Internet rewards (e.g., sexual images, identification with the characters in games) and enhancing conditioning to such rewards (Ahn, Chung, & Kim, 2015; Banca et al., 2016; Vogel et al., 2018).

It may be hypothesized that Internet-related reflexive conditioned behaviors may be elicited by Pavlovian conditioned stimuli (CS; e.g., a Social Network sound-alert for a notification) that predict the subsequent delivery of significant outcomes (e.g., a positive feedback to an individual’s web profile). Pavlovian conditioning has been proposed to involve parallel forms of associative learning including multiple types of Pavlovian responses (Cardinal, Parkinson, Hall, & Everitt, 2002). Some associations may be formed with affective/motivational aspects of outcomes, while others with sensory attributes of outcomes, thus resulting in multiple classes of Pavlovian response elicited in parallel by the same stimulus (Zhang et al., 2016). Interestingly, parallel Pavlovian responses may have different sensitivities to outcome devaluations in humans, with some responses persisting even when outcomes are no longer valued (Pool, Pauli, Kress, & O’Doherty, 2019). Considering both the number of online available cues to which individuals are often exposed and the multitude of Internet outcomes (that are characterized by subjective motivational/affective values
and several perceptual features), parallel forms of associative learning may contribute importantly to the maintenance of Internet-related Pavlovian responses. Future studies should explore this possibility. The extent to which these processes may contribute to goal-directed versus habitual behaviors and transitions between the two (e.g., via Pavlovian to instrumental transfer mechanisms (Everitt & Robbins, 2016)) warrants direct examination.

Interestingly, the influence of Internet cues on individuals’ behaviors may be enhanced by the probability of obtaining a reward. Specifically, uncertainties related to deliveries of Internet rewards (e.g., receiving likes to photos, gaining real/virtual money, receiving desirable messages, winning auctions) may increase the influence of conditioned cues on individuals’ online behaviors. In fact, the influence of environmental cues has been described to depend on probabilities of obtaining rewards; namely, when the chance of getting a reward is lower, individuals may be more influenced by cues associated with such rewards, and vice versa (Cartoni, Moretta, Puglisi-Allegra, Cabib, & Baldassarre, 2015). Given the large range of probabilities of obtaining Internet rewards and their associations with subjective perceptions of such probabilities (Sharp, Viswanathan, Lanyon, & Barton, 2012), future studies should examine whether the magnitude of the influence that conditioned Internet cues may have on individuals’ online behaviors depend on the real and/or on the subjective probabilities of obtaining Internet-related rewards.

CONCLUSIONS

To overcome some conceptual problems that are mainly related to a reliable identification of severe generalized and specific forms of IUDs, identifying core mechanisms, contextual characteristics, and diagnostic criteria has become a priority. An integrative framework for understanding cognitive, affective, and behavioral problems should form the basis of clinical research and practice for any psychopathological condition. In the case of IUDs, this seems to be particularly true given specific risks that may be related to mobile vs. non-mobile IUDs and commonalities between different IUDs that may relate to possible parallel forms of associative learning that may underlie Internet-related addictive behaviors.

Authors’ contribution: TM conducted literature searches, conceptualized the draft, and wrote the first draft of the manuscript. SC edited the draft. MP conceptualized the draft, edited and supervised the manuscript. TM, SC, and MP read and approved the final manuscript.

Conflict of interest: None of the authors have any conflicts of interest. Dr. Potenza has consulted for Rivermend Health, Opiant Therapeutics, Addiction Policy Forum, Game Day Data, Idorsia and AXA; has received research support from Mohegan Sun Casino and the National Center for Responsible Gaming; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse-control disorders or other health topics; has consulted for and/or advised gambling and legal entities on issues related to impulse-control/addictive disorders; has provided clinical care in a problem gambling services program; has performed grant reviews for research-funding agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts.

Funding sources: The present work was carried out within the scope of the research program Dipartimenti di Eccellenza (art.1, commi 314-337 legge 232/2016), which was supported by a grant from MIUR to the Department of General Psychology, University of Padua. Dr. Potenza’s involvement was supported by the Connecticut Council on Problem Gambling.

REFERENCES

Ahn, H. M., Chung, H. J., & Kim, S. H. (2015). Altered brain reactivity to game cues after gaming experience. Cyberpsychology, Behavior, and Social Networking, 18(8), 474–479. https://doi.org/10.1089/cyber.2015.0185

Banca, P., Morris, L. S., Mitchell, S., Harrison, N. A., Potenza, M. N., & Voon, V. (2016). Novelty, conditioning and attentional bias to sexual rewards. Journal of Psychiatric Research, 72, 91–101.

Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W., et al. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. Neuroscience & Biobehavioral Reviews, 104, 1–10.

Cardinal, R. N., Parkinson, J. A., Hall, J., & Everitt, B. J. (2002). Emotion and motivation: The role of the amygdala, ventral striatum, and prefrontal cortex. Neuroscience & Biobehavioral Reviews, 26(3), 321–352.

Carli, V., Durkee, T., Wasserman, D., Hadlaczky, G., Despalins, R., Kramarz, E., et al. (2013). The association between pathological internet use and comorbid psychopathology: A systematic review. Psychopathology, 46(1), 1–13.

Cartoni, E., Moretta, T., Puglisi-Allegra, S., Cabib, S., & Baldassarre, G. (2015). The relationship between specific Pavlovian instrumental transfer and instrumental reward probability. Frontiers in Psychology, 6, 1697.

Everitt, B. J., & Robbins, T. W. (2016). Drug addiction: Updating actions to habits to compulsions ten years on. Annual Review of Psychology, 67(1), 23–50.

Gary, C. S., Lakhiani, C., DeFazio, M. V., Masden, D. L., & Song, D. H. (2018a). Smartphone use during ambulation and pedestrian
trauma: A public health concern. *Journal of Trauma and Acute Care Surgery*, 85(6), 1092–1101.

Gary, C. S., Lakhiani, C., DeFazio, M. V., Masden, D. L., & Song, D. H. (2018b). Caution with use: Smartphone-related distracted behaviors and implications for pedestrian trauma. *Plastic and Reconstructive Surgery*, 142(3), 428e.

Ha, S. Y., Jung, Y. J., & Shin, D. (2020). The effect of smartphone uses on gait and obstacle collision during walking. *Medical Hypotheses*, 109730.

Kim, H. (2013). Exercise rehabilitation for smartphone addiction. *Journal of Exercise Rehabilitation*, 9(6), 500.

Kim, H. J., Min, J. Y., Kim, H. J., & Min, K. B. (2017). Accident risk associated with smartphone addiction: A study on university students in Korea. *Journal of Behavioral Addictions*, 6(4), 699–707.

Kitazawa, M., Yoshimura, M., Murata, M., Sato-Fujimoto, Y., Hitokoto, H., Mimura, M., et al. (2018). Associations between problematic Internet use and psychiatric symptoms among university students in Japan. *Psychiatry and Clinical Neurosciences*, 72(7), 531–539.

Lennon, A., Oviedo-Trespalacios, O., & Matthews, S. (2017). Pedestrian self-reported use of smart phones: Positive attitudes and high exposure influence intentions to cross the road while distracted. *Accident Analysis & Prevention*, 98, 338–347.

Luria, G. (2018). The mediating role of smartphone addiction on the relationship between personality and young drivers' smartphone use while driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 59, 203–211.

Metz, B., Landau, A., & Just, M. (2014). Frequency of secondary tasks in driving—Results from naturalistic driving data. *Safety Science*, 68, 195–203.

Montag, C., Wegmann, E., Sariyska, R., Demetrovics, Z., & Brand, M. (2019). How to overcome taxonomical problems in the study of Internet use disorders and what to do with “smartphone addiction”? *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.8.2019.59. In press.

Moretta, T., & Buodo, G. (2018). Autonomic stress reactivity and craving in individuals with problematic Internet use. *PLoS One*, 13(1), e0190951.

Moretta, T., & Buodo, G. (2020). Problematic Internet use and loneliness: How complex is the relationship? A short literature review. *Current Addiction Reports*, 7, 125–136.

Moretta, T., Sarlo, M., & Buodo, G. (2019). Problematic internet use: The relationship between resting heart rate variability and emotional modulation of inhibitory control. *Cyberpsychology, Behavior, and Social Networking*, 22(7), 500–507.

Mourra, G. N., Senecal, S., Fredette, M., Lepore, F., Faubert, J., Bellavance, F., et al. (2020). Using a smartphone while walking: The cost of smartphone-addiction proneness. *Addictive Behaviors*, 106, 106346.

Nemke, H. E., & White, K. M. (2010). Texting while driving: Psychosocial influences on young people’s texting intentions and behaviour. *Accident Analysis & Prevention*, 42(4), 1257–1265.

O’Brien, N. P., Goodwin, A. H., & Foss, R. D. (2010). Talking and texting among teenage drivers: A glass half empty or half full?. *Traffic Injury Prevention*, 11(6), 549–554.

Pool, E. R., Pauli, W. M., Kress, C. S., & O’Doherty, J. P. (2019). Behavioural evidence for parallel outcome-sensitive and outcome-insensitive Pavlovian learning systems in humans. *Nature Human Behaviour*, 3(3), 284–296.

Sharp, M. E., Viswanathan, J., Lanyon, L. J., & Barton, J. J. (2012). Sensitivity and bias in decision-making under risk: Evaluating the perception of reward, its probability and value. *PLoS One*, 7(4), e33460.

Stavropoulos, V., Gomez, R., Steen, E., Beard, C., Liew, L., & Griffiths, M. D. (2017). The longitudinal association between anxiety and Internet addiction in adolescence: The moderating effect of classroom extraversion. *Journal of Behavioral Addictions*, 6(2), 237–247.

Vogel, V., Kollei, I., Duka, T., Snagowski, J., Brand, M., Müller, A., et al. (2018). Pavlovian-to-instrumental transfer: A new paradigm to assess pathological mechanisms with regard to the use of Internet applications. *Behavioural Brain Research*, 347, 8–16.

Wagner, R., Gosemann, J. H., Sorge, I., Hubertus, J., Lacher, M., & Mayer, S. (2019). Smartphone-related accidents in children and adolescents: A novel mechanism of Injury. *Pediatric Emergency Care*. https://doi.org/10.1097/PEC.0000000000001781. In press.

Young, K. L., & Salmon, P. M. (2012). Examining the relationship between driver distraction and driving errors: A discussion of theory, studies and methods. *Safety Science*, 50(2), 165–174.

Zhang, S., Mano, H., Ganesh, G., Robbins, T., & Seymour, B. (2016). Dissociable learning processes underlie human pain conditioning. *Current Biology*, 26(1), 52–58.