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The physiology of play: potential relevance for higher education

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ABSTRACT

This paper explores the physiology of play and its potential for advancing higher education through promoting joy and counteracting performativity, which we argue is a proponent of mental ill-health in the sector. Although play is increasingly recognised as a fundamental part of the human experience and a successful teaching practice, it is only consistently applied within childhood education. We identify 3 key areas of play physiology relevant for higher education: physical and mental resilience; social intelligence; cognitive flexibility and intellect. We conclude that the incorporation of play within higher education by developing 'Playful Universities' could counteract the fear of failing, avoidance of risk and other negative aspects of performativity and goal-oriented behaviour. Playful learning, therefore, challenges the continued relevance of focusing on a dehumanising and oppressive neoliberal model of performativity-based learning and sheds light on the potential of a joyous, authentic transition to the co-creation of knowledge within higher education.

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Introduction

Could a greater and clearer understanding of the physiology of play advance higher education? Imagine a place of learning where progressive failing, building resilience and developing individual and collective skills, values, and creativity are not only thought about as a theoretical exercise, but fostered within the pedagogic culture. A place where academic drive is created and nurtured through joy, engagement and play, where learning to solve problems and overcome obstacles is a reward in its own right. Is this not what learning is about? Unfortunately, the predominant narrative within current neoliberal education reform sees a continued focus on performativity-based indicators of successful learning (Ball, 2015; Brown & Vaughan, 2009). The insidious impact of this ethos penetrates deep into the classroom, affecting both teachers and students alike and thus provoking both individual and collective stressors. Statistically, the influence of neo-liberal politics and endorsement of a performance-based education culture is proposed to be a main contributor to the global trend of young people struggling with increased educational

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pressures, resulting in a dramatic and unprecedented increase in the prevalence of anxiety and mood disorders (Ball, 2012; Brown & Vaughan, 2009). Recently, these concerns were underlined by the World Health Organisation's observation that mental disorders were present in 1/3 of first-year students in 19 colleges across 8 countries (Auerbach et al., 2018). These staggering figures present us with an urgent need to consider alternate educational philosophies to protect educational authenticity and what Stephen Ball aptly names the 'teachers' soul'. As a focus point, we therefore consider the question - could the physiology of play teach us how to improve student experience, satisfaction and well-being whilst also increasing the existential authenticity of our work as teachers?

Although play often appears to have no end or purpose, it does have profound biological effects on the normal functions of living. Consequently, this has direct effects on how we feel, behave and function. As will be discussed, human and animal experiments studying the physiology of play show that play can promote survival, problem solving capabilities, joy, cognitive flexibility and social competence. Interestingly, play also promotes intellectual dexterity, individual resilience and adaptability. Indeed, playful learning is increasingly recognised as both a fundamental part of the human experience and a paradigm to improve pedagogical practice (Nørgård, Toft-Nielsen, & Whitton, 2017; Brown & Vaughan, 2009; Whitton, 2018). However, this has been mostly addressed in childhood (Liu et al., 2017; Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009; Whitton, 2018; Yogman, Garner, Hutchinson, Hirsh-Pasek, & Golinkoff, 2018), is very limited in adulthood (Brown & Vaughan, 2009; Whitton, 2018) and even less so in higher education (Whitton, 2018).

What is play?

Play is easy to recognise – in most cases behaviour can be classified as either play or non–play – and is nearly ubiquitous in all mammalian orders and other classes of animals, but it is incredibly hard to define. Defining play and investigating the biological functions of play is therefore an ongoing and lively debate (Burghardt, 2005; Huizinga, 1949; Panksepp, 1981, 2005; Panksepp & Burgdorf, 2003; Panksepp, Siviy, & Normansell, 1984; Pellis & Pellis, 2017; Sutton-Smith, 1998). Common definitions describe play as an activity or expression that is fun, enjoyable, voluntary and non-serious (Caillois, 2001; Csikszentmihalyi, 1990; Huizinga, 1949). Play further involves an in–the–now attitude characterised by concentration and focus (Csikszentmihalyi, 1990; Huizinga, 1949), and promotes social grouping (Huizinga, 1949). Within this paper, when we disclose the potential relevance of play for higher education, an adapted definition proposed by Van Vleet and Feeney will be used to address adult play (adaptations in cursive): 'Play is an activity or expression that is carried out with the goal of *increasing joy with respect to oneself and their surroundings*. It involves an enthusiastic and *in-the-now* attitude or approach and is highly interactive among players or with the activity itself ' (Van Vleet & Feeney, 2015). Using this definition, play can relate to games and sport but can certainly also extend to other activities that can increase joy, which we strongly argue is inclusive of learning. Furthermore, play becomes an expression which is very personal, contextual, creative, cultural and is an integral part of the human experience. Considering this, play as an entity is tightly allied with quality of life and does not necessarily have to interfere, as common stigma dictates, with the arguably more 'serious activities' of life, such as education and work. Rather the opposite, if used effectively, play can have significantly positive effects on both. Indeed play, work

and learning are not mutually exclusive, as Stuart Brown states: 'The opposite of play is not work – it is depression' (Sutton-Smith, 1998).

Physiology of play

In order to discuss how play can potentially improve learning within higher education, as we will argue, we need to address what role play has within the normal functions of living organisms and their parts, i.e. what is the 'physiology of play'. Traditionally, biologists find play enigmatic as the mechanism linking play to ecology and evolution remains elusive. The common theory that play prepares the individual for the challenges of adulthood has been increasingly proven to be incomplete. For example, there appears to be no correlation between playing as a young kitten and becoming a competent predator as an adult cat (Caro, 1980), and play fighting in young meerkats does not affect subsequent serious fighting in adulthood (Sharpe, 2005). Furthermore, many species demonstrate play, or at least play-like behaviour, in adulthood. Here, examples include primates, rats, cats, dogs, ravens, bison, hippos, dolphins, octopus, fish, and many more (Hall, 1998). Reviewing the evidence in this area, alongside our personal experiences, we argue that physiology of play is relevant for learning in 3 key areas; (i) physical and mental resilience, (ii) social intelligence, and (iii) cognitive flexibility and intellect.

Before we address these 3 key areas, we will briefly discuss some of the main neurobiological functions that are linked with the physiology of play, i.e. how is the brain involved during play behaviour? The complex neurobiological physiology of play involves many brain centres and neurotransmitters (Bateman & Nacke, 2010; Liu et al., 2017), and has been strongly linked with the reward and social components of play. These systems are well documented in neurological and biological literature, for example Vanderschuren et al. extensively review the neurobiology of play and its rewarding value in rats (Vanderschuren, Achterberg, & Trezza, 2016). For our paper, we will briefly discuss the neurotransmitters dopamine, serotonin and oxytocin as key examples underpinning the neurobiological physiology of play, which will frame our discussion moving forward. In relation to play, the dopaminergic system is commonly associated with pleasure and is involved with habit formation and reward-seeking behaviours (Bateman & Nacke, 2010). This reward system, including the midbrain, striatum, hippocampus, and prefrontal cortex, is intimately associated with feelings of joy and excitement linked to enhanced memory, attention, mental shifting, creativity, and motivation (Liu et al., 2017), but importantly may also produce stress, frustration and addiction. Often, the exciting and rewarding aspects of play lie in the tension or ambiguity between creation and destruction (Sutton-Smith, 1998). For example, a rollercoaster ride can be enjoyable as it mimics the threat of getting hurt, but becomes stressful when one no longer trusts the ride to be safe. In addition, when play is deprived of joy, it can promote performance anxiety, addiction and aggression through dopamine dysregulation, particularly in the presence of serotonergic deficiency (Seo, Patrick, & Kennealy, 2008). The serotoninergic system, which has fairly extensive and diffuse projections throughout the forebrain, is associated with almost all behavioural and emotional processing (Berger, Gray, & Roth, 2009), where dysfunction is linked with depression and anxiety, and gain of function is linked with happiness, contentment and empathy. For example, central serotonergic activity and serotonergic receptors are traditionally targeted to treat neuropsychiatric disorders like

schizophrenia and depression (Berger et al., 2009), while individuals with more efficient serotonin transporter genes report significantly higher levels of life satisfaction (De Neve, 2011) optimism (Fox, Ridgewell, & Ashwin, 2009) and altruism (Gärtner, Strobel, Reif, Lesch, & Enge, 2018). Therefore the serotonergic system is unquestionably and intimately involved in the long-term effects of play on wellbeing, although the underlying mechanisms are not fully understood. In relation to play behaviour serotonin is thought to have a subtle role in modulating play behaviour, and influences interactions between play partners (Siviy, Deron, & Kasten, 2011). In addition, serotonin levels may modulate play through interactions with the dopaminergic system (Siviy et al., 2011). Oxytocin is synthesised within the hypothalamus and is stored in and released by the pituitary (Meyer-Lindenberg, Domes, Kirsch, & Heinrichs, 2011) in response to stimuli like touch, eye gaze, massage, intimacy and playful interactions (Uvnas-Moberg & Petersson, 2005). Oxytocin is well-established as an enhancer of social behaviour and feelings of togetherness and has been proposed as a key neurotransmitter associated with social competence (Declerck, Boone, & Kiyonari, 2010), pair bonding (Liu & Wang, 2003) and social learning (Xu, Becker, & Kendrick, 2019). As dopamine and oxytocin can create interactions between reward and the social brain centres, including the nucleus accumbens (Liu & Wang, 2003), it might be part of the physiological mechanism behind the proverb 'the family that plays together stays together'.

Physical and mental resilience

Play is physiologically relevant due to its positive effect on cardiovascular health, keeping those partaking healthy throughout their lives. Indeed, Proyer *et al.* observed that playfulness positively correlated with cardiorespiratory fitness and specific health behaviours (Proyer, Gander, Bertenshaw, & Brauer, 2018). In addition, it has been more commonly accepted that play, at least in mammals, can be used as both physical and mental training or preparation for the unexpected (Spinka, Newberry, & Bekoff, 2001). The relevance of this aspect of play for learning is elegantly worded by James Carse who stated: 'To be prepared against surprise is to be trained. To be prepared for surprise is to be educated' (Carse, 1986). This underlines the observations that if unforeseen and challenging circumstances in life have been practiced or experienced, even as incremental parts, in a safe and familiar environment, the individual will deal with these circumstances in a more capable and successful way. Furthering this argument, one could postulate that training for the unexpected may in fact lead to an overall increase in both short and long term survival. Crucially here, Fagen and Fagen observed for the first time a link between play and increased short-term survival in brown bears (Fagen & Fagen, 2004). They found that a brown bear cub has a greater chance of survival in the first year if s/he plays more. This observation suggests an immediate cost/benefit trade-off for play regarding short-term survival and thereby supports the proposition that play prepares the individual for the challenges throughout life. What does this mean for the mental resilience?

One distinct and key play behaviour in humans is laughter. Panksepp *et al.* demonstrated how rats can reflect their positive affective state by a 50-kHz ultrasonic vocalisation, i.e. rat laugher (Liu et al., 2017; Hirsh-Pasek et al., 2009; Whitton, 2018; Yogman et al., 2018). Extraordinarily, rough-and-tumble play in rats (a playful activity in which rats engage well into their adulthood) induces excessive laughter, which can lead to

resilience against depression and anxiety, and facilitation of learning and memory (Burgdorf, Colechio, Stanton, & Panksepp, 2017). These effects are mediated, in part, by increased plasticity in the medial prefrontal cortex (Burgdorf et al., 2017; Panksepp, 2005). This brain area is believed to play a pivotal role in emotional responses partly via the dopaminergic system. As rough–and–tumble requires significant social intelligence, it is interesting to note that depriving young rats of play has a negative impact on their social intelligence (van den Berg et al., 1999).

Social intelligence

Social play experiences in rats during adolescence appear to produce long lasting effects on both behaviour and stress-related neural circuits, including the medial prefrontal cortex (Burke, McCormick, Pellis, & Lukkes, 2017). For example in rats, deprivation of social play in adolescence alters the dopaminergic modulation of the medial prefrontal cortex, impairing decision making under novel or challenging circumstances (Baarendse, Counotte, O'Donnell, & Vanderschuren, 2013). Conversely, increased playful social interactions in rodents have been shown to improve the integration of the pre-frontal cortex for learning complex behaviours like self-regulation and planning (Bell, Pellis, & Kolb, 2010; Pellis & Pellis, 2007; Pellis, Pellis, & Himmler, 2014), and enhance neural plasticity (Himmler, Pellis, & Kolb, 2013). This plasticity of the brain in adult life is strikingly demonstrated by the observation that rough-and-tumble play facilitates positive emotional learning and induces resilience to depression in late-adolescent (adult) rats (Burgdorf et al., 2017). Interestingly, studies further solidify this concept by demonstrating that for an increased brain plasticity to occur, play with toys used in the experiment must occur with other rats in a playful social interaction as opposed to individually (Burgdorf et al., 2017; Diamond et al., 1987; Diamond, Krech, & Rosenzweig, 1964; Diamond, 1988).

On the other hand, lesions of neuronal pathways in the prefrontal cortex can impair both juvenile play and adult social behaviour in rats (Pellis et al., 2006). What does this mean for the typical age (i.e. late adolescence-adult) at which students do most of their higher education? In adolescence, following the juvenile neuronal proliferation, the brain rewires itself from the onset of puberty up until 24 years old, especially in the prefrontal cortex (Arain et al., 2013). Depriving mice of social contact and play during mid-adolescence dysregulates prefrontal cortex function, resulting in altered social behaviour and impairing learning, attention and cognitive flexibility (Lander, Linder-Shacham, & Gaisler-Salomon, 2017). Taking this even further, when late adolescent (adult) rats are deprived of physical interaction with other rats, like rough-and-tumble play, they become depressed (Burgdorf et al., 2017) and do not possess the social skills to separate appropriate from inappropriate aggression (Pellis & Pellis, 2017). One might therefore wonder what social (and functional) consequence play (or the absence thereof) can have for the individual throughout life. For humans, the complete absence of play is the most palpable example of the importance and necessity of play in life. Brown has demonstrated this by observing, within several clinical studies, that normal play and play-like behaviour was virtually absent throughout the lives of highly violent and socially incompetent individuals, independent of demographics (Brown, 1998). Could we imagine a society deprived of free and joyful play, how would our brain function socially?

Strikingly, when temporarily play deprived adolescent rats are placed back with their playmates, they will play significantly more to catch up on all the play that they have missed (Holloway & Suter, 2004). This rebound play is very similar to rebound sleep after sleep deprivation and again appears to be independent of the availability of play-like alternatives like toys (Holloway & Suter, 2004). The latter underlines that true play requires an attitude or approach which is highly interactive among players or with the activity itself. Is play as essential as sleep for a normal healthy life? Like many other key physiological mechanisms, play can display a circadian rhythm (Ahloy Dallaire & Mason, 2016), further suggesting that play is in itself a physiological process and goes far beyond just being an enjoyable experience.

Taken together what we have learned from the relevance of the physiology in physical and mental resilience and social intelligence, we could conclude that prospective students need to play rough–and–tumble as much as they can prior to and during their time within higher education, particularly for the novel challenging transition period during the first year. Whilst this statement is mentioned tongue–in–cheek, it draws significantly on the sweeping wellbeing agenda we are seeing in many areas of educational and vocational life. Arguably, using this knowledge of play physiology, universities promoting a more playful philosophy could and should incorporate time with which to explore the 'rough-and-tumble' ethos through engaging in co-designed exercise offerings and spaces within curriculums for sports, nature–based activities and other forms of mental and physical exercise in order to stimulate development of resilience and social intelligence.

Cognitive flexibility and intellect

Within the animal kingdom, the proportion of the lifespan spent as a juvenile is positively correlated with the relative size of the non-visual neocortex (Joffe, 1997). This part of the brain is associated with intellectual abilities such as solving social problems and cognitive memory. Does this mean that long juvenile periods among socially intelligent species contributes to the development of their intellectual abilities, and is a long juvenile period correlated with more play? This appears to be the case, at least in some species of rodents, primates, and birds, where the species with the most complex play–behaviour have the longest juvenile period and have the largest and most adaptive brains.

Concurrently, a comprehensive study comparing relative brain size across 15 mammalian orders revealed a significant relationship between play and relative brain size (Iwaniuk, Nelson, & Pellis, 2001). This means that the orders which contain species with larger brains, and hence increased intellectual abilities, also contain species that both play more and have more complex play–behaviour. Kerney *et al.* observed a functional relationship between play and relative size of the cortico–cerebellar brain regions within 19 species of primates (Kerney, Smaers, Schoenemann, & Dunn, 2017). This brain system is associated with complex skills, foraging, tool use, and social competence. Presumably, larger brains allow for cognitive complexity and increased intellect. This begs the question - does play in itself make a brain larger and hence enable learning, or does a larger brain allow for more play? To answer this, there is compelling evidence by Marian Diamond, one of the founders of modern neuroscience, that rats playing with toys can enlarge and modify structural components of their brain at any age (Diamond et al., 1964; Diamond et al., 1987; Diamond, 1988). This suggests that play can indeed increase

brain size and function, and that this is not confined to the juvenile period. Moreover, play can have both long and short-term impact on cognitive function.

To give an example on how play can have an immediate effect on cognitive flexibility, the study by Zabelina and Robinson is of interest. Within this study the authors found that when 76 students approached a test of creative thinking (Torrance Test of Creative Thinking [TTCT] (Torrance, 1974), arguably a gold standard measure in the creative performance literature) as playful 7-year–olds, they produced significantly more original and creative responses (5.72 responses that were unique and original) than when under control conditions (4.33 responses that were unique and original, $p < 0.05$) (Zabelina & Robinson, 2010). Moreover, when pre-school aged children are asked to perform a challenge that involves creativity, experimentation, communication and fine motor skills they perform significantly better than the adult average (Anthony, 2014; Wujec, 2016). It is therefore tempting to conclude that the pre-school aged children outperformed the adults because they completed the challenge utilising a more playful (juvenile) approach, where failing is learning. Does this mean that in order to stimulate cognitive flexibility and intellect we have to think like 7–year olds? Although this would be highly impractical, it does offer us insights on how to promote creative thinking, which is often the Holy Grail in higher education.

Potential relevance for higher education

We argue that the physiology of play allows for the, partly under–used, potential of play to improve physical and mental resilience, social intelligence, and cognitive flexibility and intellect. Obviously, the potential positive impact of play within higher education is more complex than simply introducing more play activities. Nevertheless, play within education is by no means a new concept. However, the world we live in now is remarkably different from how it was 20 or even 10 years ago. The way we communicate, interact and play has dramatically changed, and continues to do so, due to increasingly rapid scientific, economic, social and political changes. The internet, smart phones, social media etc have altered the social landscape radically, simultaneously giving rise to new opportunities within higher education. In addition, there is an increased and urgent need for addressing wellbeing with the rising epidemic of mental ill health. For example the global incidence of murder due to violence and war is lower than the incidence of suicide: 6 vs 11 in every 100,000, respectively (UNODC, 2013; WHO, 2016). This is substantiated by alarming figures in the United Kingdom from the NHS and the Chief Medical Officer, stating that 1 person in 4 will experience some form of mental health issue in any given year (Taskforce, 2016) and, relevant for aspiring students, that 75% of adults accessing treatment for mental ill health had a diagnosable condition prior to the age of 18 (Davies, 2014). As previously discussed, the physiology of play delivers evidence that play can promote intellectual dexterity, individual resilience and adaptability. These important attributes, amongst many others, could help us to adapt in a challenging world and curb the apparent epidemic of stress, anxiety and related mood disorders. Therefore, in a time in which our cherished education is becoming increasingly pressurised for performance and output, there is an urgent need to further unfold the potential of play that can increase joy (e.g. by optimal stimulation of neurological pathways) to advance our knowledge processing while simultaneously acting as an adjunct to counteract mental ill health.

We argue that higher education institutes could spearhead this urgent need, becoming some of the first establishments to foster a constructive, co–designed contribution to the development of resilience and wellbeing amongst staff and learners through play.

The implementation of play in a highly performance orientated education system is however a challenge and, whilst the negative effects of performativity-based education have not gone unnoticed, continuing critical pedagogy critique is required in order to foster radical change. Such discussion is already growing through authors such as Stephen Ball and Alfie Kohn, who prominently contest performativity-based education. Indeed, collectively these authors argue that our obsession with performance perpetuates an environment with less interest in learning, reduced desire for attempting challenges and a decline in creativity, resulting in poorer standards of learning and work. We argue that this growing discussion is taking place in parallel with the emergence of playful teaching approaches within higher education. These include many types of playful teaching, learning and academic practices (Whitton, 2018), and a signature pedagogy of playful learning in higher education (Nørgård et al., 2017). Although application remains both limited and privileged, this is considered to be a promising starting point for further development of 'Playful Universities' with 'Playful Curricula' and 'Playful Academics'. Such curricula could, for example, make use of existing playful teaching approaches like gamification (Markopoulos, Fragkou, Kasidiaris, & Davim, 2015), role play (King, Hill, & Gleason, 2014), curricula co–design (Aguilar, Holman, & Fishman, 2015), and escape rooms (Samantha Jane et al., 2017). There is a plethora of playful learning tools on the market ranging from simple quiz-based platforms to full gaming systems. To give a practical example of an ongoing study, we are using an online platform called Redgrasp (www.redgrasp.com) that sends out a 'Question of the Day' by email. Students answer these questions in teams to gain points and badges, working towards an eventual 'End of Campaign Prize!'. After answering each question, students get feedback on how others have answered and a short explanation of the correct answer. They are then directed to interactive videos and other constructively aligned learning content on their virtual learning environment (VLE), thus creating a learning loop. What have we found so far using this simple, playful intervention? Overall, anecdotal evidence suggests a significant increase in engagement with the available learning materials, knowledge retention to practical sessions and student satisfaction. Research is however required to fully explore the impact of this intervention. Despite this, with our current experience we argue that playful micro-learning tools like Redgrasp hypothetically reinforce the students' intrinsic motivation/curiosity and playfulness (dopaminergic system), social competence (serotoninergic and oxytocinergic system) and their state of flow - a concept discussed later in this article. Interestingly, such tools have already been linked with circumventing the sensation of mental exhaustion and facilitating the movement of learned material from short-term to long-term memory (Shail, 2019). Further inspiration could be found within existing playful childhood pedagogy, the gaming industry, social sciences and creative industries, etc. Strikingly, while many teaching approaches might be defined as types of playful teaching, they often do not self-identify as such, revealing a sense of disrepute around students learning playfully, thereby hindering efforts to increase awareness on how play can contribute to the educational experience.

Within most cultures, there appears to be a continuing stigma of play to be frivolous and a waste of time and energy. Indeed, play in rats only occurs once primary bodily

needs have been met. For example Siviy and Panksepp have shown that 24 h food deprivation reduced play (Siviy & Panksepp, 1985). On the other hand, this study also observed an overall resilience of play in response to somewhat severe homeostatic challenges, which underlines the strength of play as a highly preserved behaviour. This is exemplified by the observations that long-term play deprivation is highly detrimental for individual wellbeing and even for survival (Holloway & Suter, 2004; Brown, 1998). On the other hand, there are observations which show that play behaviour will be preserved in the face of considerable risk, for example one study showed that the vast majority of young seals caught and killed by sea lions were playing at the time (Harcourt, 1991). Another study showed that within the extermination camps of world war II, the children who were still healthy enough to move around did continue to play (Eisen, 1988). These observations, together with the discussed physiology of play, do strongly underline the necessity of play in life. Regardless, there is a continuing debate surrounding the efficacy and ethical implications of incorporating playful strategies within higher education, which may have negative effects on learning when poorly utilised (Kim & Werbach, 2016; Langendah, Cook, & Mark-Herbert, 2016). Often these strategies are used to increase student engagement while focussing mainly on competitive outcomes like points, leaderboards, badges and rewards, echoing the undesirable culture of performativity–based indicators. In contrast, we argue that play should be used to create a joy and authentic co–creation of knowledge.

In order to move away from performativity-based play interventions, it is pivotal to understand how play can engage and drive the student to learn. This requires attending to theories of intrinsic and extrinsic motivation. Such literature dates as far back as the 1940s, where Harlow *et al.* observed that monkeys were intrinsically motivated to solve puzzles without a reward (Harlow, Harlow, & Meyer, 1950). In this study, playfully solving a puzzle and hence overcoming an obstacle or solving a problem was its own reward. In fact, when offered a treat as a reward, so called extrinsic motivation, the monkeys made more errors and solved the puzzles less frequently (Harlow et al., 1950). Importantly, this is mirrored in human behaviour, where it is evident that humans are also intrinsically driven to create and solve puzzles/problems and overcome obstacles (Pink, 2009), while an increasing number of studies have confirmed that rewards like monetary incentives are generally detrimental for performance (Pink, 2009; Wujec, 2016). For example, where most participants could complete a challenge that involves creativity, experimentation, communication and fine motor skills, they all failed when offered a $10,000 prize if they were the best in doing so (Anthony, 2014; Wujec, 2016). Presumably the monetary incentive promoted anxiety to a level that impaired creativity and performance. Considering this, it is interesting how our current educational systems focus on extrinsic motivations and extrinsic performance indicators (grades, degrees, post-graduate employment or salary prospects) and how also, if gamification is employed, systems such as points, leaderboards and badges, again extrinsic motivators, are favoured.

This poses the question as to whether joy, engagement and play, which are linked with intrinsic motivation, are ever justly fostered within academia or society in general. Consider the following experiment where Cheng and Muir attempted to increase the egg –laying productivity of hens by breeding with the most productive hens (Cheng & Muir, 2004). Instead of producing a strain of hens with increased egg –laying productivity the experiment produced a strain of hyper-aggressive hens, which plucked each other

incessantly, killed 2/3 of all the hens and produced almost no eggs (Cheng & Muir, 2004). This study is suggestive (although not investigated) for an impaired social intelligence mirroring play deprivation. This reveals a naiveté in the idea that creating the best graduates is merely a matter of selecting the 'best' individuals and must lead us to consider how we judge performance and what 'best' truly means to us. Transposing these observations to education, we argue that quality higher education will require working together to create what cannot be produced alone, or at least to refrain from exploiting each by promoting a capitalistic 'winner–takes–all' culture, and thereby promoting mental resilience, social intelligence and cognitive flexibility. This is concurrent with the observations, as previously discussed, that the benefits of play also depend on the interactions between players. Most people have experiences where they have put in significant extra work without feeling the extra effort if the educator and/or their peers were involved in a playful interaction. For example, as a response to an online questionnaire on personal play history, an educator recalled that a class of students happily did double the workload in a Latin and Greek class because the teacher deviated from the original curricula to let the class translate a selection of texts that where humorous and interesting to all involved (unpublished). This playful interaction created an engagement that included joy, fun, laughter and curiosity toward the next assignments, which arguably can be considered quite an achievement for teaching teenagers Greek and Latin.

Perspective

When an individual is playing, she is both simultaneously exercising and refining the familiar, and embracing the unpredictable and surprising. Therefore, play is an act of personal development which can be closely linked with learning. For example, learning how to play rugby, including memorising many new rules and regulations, will refine the mastery of physical functions like running and catching, while simultaneously developing social competence within a group of individuals, promoting social intelligence. Eventually, this learning will enable a rugby team to react or interact successfully, or at least appropriately, with the highly unpredictable and surprising conditions that will inevitably arise after kick-off on any given game day, promoting physical and mental resilience.

We have briefly reviewed the evidence on the physiology of play to argue that there remains an unused potential of play for learning and education. To further integrate our understanding of the physiology of play with the applicability of play in higher education, further exploration is needed to find answers for many relevant questions. For example: Does an increased sense of joy engage individuals in intellectual dexterity (like creative thinking), or does the opportunity to engage in creative thinking increase joy? Which forms of play promote creativity, social competence, or individual resilience, and by what mechanisms? Are there differences between geographical and cultural contexts, and if so, why? And many more. Ultimately, increasing our understanding will help design pedagogical practices which can successfully facilitate learning through play in higher education and beyond.

In addition, to make progress with playful education, more and more diverse playful teaching strategies should be developed and applied both consistently and effectively within higher education. Interestingly, much of the strategy for applying a playful philosophy is readily available to be learnt from the ever-successful gaming industry. This

industry has been incredibly successful in compelling us to play, using effective methods to ensure adequate 'flow', described by positive psychologist Mihály Csíkszentmihályi as an optimal psychological state where psychic energy is effortlessly focussed on clear and achievable goals that provide relevant and immediate feedback to the individual (Csikszentmihalyi, 1990, 1997). Thus, we see that acquiring new and complicated skills within a video game can take hours of patient and often meticulous learning, but that this learning can feel almost effortless to the player. When playful learning promotes a state of flow, it will increase intrinsic drive because of a sense of effortlessness between joy, learning and acquiring skills, just as we see when progressing through levels of a game. Indeed, playing video games have shown to alter the brain, improving sensory, perceptual, and spatial cognitive functions, and both basic and complex spatial tasks throughout life, promoting cognitive flexibility and intellect, and can be long lasting (Spence & Feng, 2010). This ethos has already been adopted by many of the most prominent organisations within our society, such as Google, Facebook, LinkedIn and Netflix. These pioneering institutions have embraced the concepts of learning and expressing creativity through play at the workplace by adopting anti-bureaucratic practices and creating 'flow friendly environments'. Does this always mean that an individual can find her flow through play? Not necessarily, flow is very complex and depends on both the context and the person. Besides, as described by the reversal theory (Apter, 1984), flow can also be changeable and inconsistent. For example, if you are watching your favourite Netflix series, you are relaxed with a pleasant sensation and, usually, a low level of stimulation. If after 5 min you realise you have already seen this episode your flow instantly changes to a feeling of being bored, with an unpleasant sensation and a low level of stimulation. Conversely, you can instantly change from excited to anxious as previously explained with the rollercoaster ride mimicking the threat of getting hurt to no longer trusting your safety. Attaining and keeping the flow of students has always be one of the greatest challenges within any education. Understanding how game design can do this will potentially help to make this achievable within education.

Conclusion

Creating more awareness of how play can contribute to the educational experience will progress higher education while combating contemporary issues. The potential benefits of play, as evidenced by the physiology of play, and how this can be incorporated within higher education should be brought to the political sphere, institutional practice and wider social field. This should not only include facts and practices or approaches, but will also need to include training to (re)connect with individual and institutional playfulness, enabling an academic culture, with 'Playful Academics' that supports joyous, authentic transition to the co-creation of knowledge.

To close, in order to take full advantage of play in higher education we should not move away from one of the most fundamental aspects of play, which we argue is joy. Joy is intimately interconnected with the neurobiological pathways linked with play, which are shown to have some level of plasticity throughout life. Indeed, joy appears to be linked with all 3 proposed key areas of play physiology relevant for learning. For example, with a positive belief in one's future (physical and mental resilience), togetherness (social intelligence) and creativity (cognitive flexibility and intellect). If higher education

can foster play in a way that increases joy, for example by allowing the cultivation of intrinsic motivators by actively counteracting performativity through play, education could become equal to learning how to solve puzzles and overcome obstacles through experimentation and curious exploration. Developing a 'Playful University', a place of learning that embraces some form of play, will allow us to promote progressive failing, building resilience and developing individual and collective creativity. Consequentially, this will make the 'what', 'how' and the 'where' students can learn in the coming generations unpredictable and surprising, which we should collectively embrace playfully.

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Data availability statement

This study did not generate any new data.

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