Design Inspiration for Motivating Uncertainty in Games using Stage Magic Principles

Shringi Kumari

Doctor of Philosophy
University of York
Computer Science
May, 2021

“There is no terror in the bang, only in the anticipation of it.”

- Alfred Hitchcock

Abstract

Uncertainty is widely acknowledged as an engaging player experience. Practice and research have proposed various types of game uncertainty, yet there is little work explaining *when* and *why* they motivate, especially with respect to 'micro-level', moment-to-moment gameplay. Moreover, there is little insight into *designing* for motivating uncertainty in games. In response, this research aims to answer (1) what constitutes motivating moment-to-moment uncertainty and (2) how to elicit it through game design, taking inspiration from stage magic.

We survey player motivation, player experience and related literature in psychology, exposing underrepresentation of epistemic emotions in games. We showcase the motivating role of uncertainty in moment-to-moment gameplay, proving its link to curiosity and other epistemic emotions. We present this with a grounded theory taxonomy of seven types of engaging gameplay uncertainty emerging from three sources - game, player, and outcome.

For inspiration, we survey the field of stage magic to find design principles used to elicit epistemic emotions. We identify *equivoque*, an important forcing technique, to create the illusion of choice and thus engaging *decision uncertainty* in games. We empirically test the efficacy of *equivoque* through three studies: (1) using playing cards; (2) in a narrative game to create *decision uncertainty*; (3) repeating the trick four times consecutively in an extended version of the game.

Overall, our work exposes gaps in player motivation research, especially regarding empirical work on epistemic emotions in games. It provides a taxonomy of motivating uncertainty types. It establishes magic as a promising source of game design inspiration, and zeroes down on *equivoque* for evoking uncertainty. Furthermore, it provides empirical evidence that *equivoque* can be used in narrative games to elicit *decision uncertainty*. Finally, it provides insights into translational work between creative fields and from theory to design.

Contents

List of Figures

List of Tables

Acknowledgements

"I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference. "

- Robert Frost (Frost, 1921)

This PhD has confirmed that there is no perfect decision or outcome. It is all about how we embrace the uncertainty that comes with the choices we make. Academia, as I have come to understand, can often be a rigid world. Sebastian's invaluable contribution to my PhD has been to not discourage me from traveling the road less taken, his willingness to accept change, experimentation and the uncertainty of it all. He has managed to do this while asking realistic questions and being open-minded even in sharp disagreements. Ironically, I have found this to be a rare virtue in a field that strives to make path-breaking discoveries.

During this PhD, I have come to understand the importance of following instincts, having *fun* and being with people who believe in me and are excited for me. I thank Jo Maltby for her warmth and for supporting me in taking the first step in going 'astray'. I thank my supervision team - Sebastian, Gustav, Anders and Jonny for giving me the room to make unusual decisions while asking difficult questions. I thank Goldsmiths for providing the much needed creative infrastructure along with opening the avenue to the field of magic. I thank the University of York for pushing for integrity and rigour in research. I thank IGGI for investing in games research.

I thank Abhishek and my brilliant luck that I have him by my side. He has listened to my rants, given me strength in times of crisis and most importantly reminded me that I am doing this PhD with no compromises whatsoever, and that is a great spot to be in. I thank Henrik and Cris for being exceptionally honest and inspiring researchers, along with being incredible friends imparting love and wisdom along the way. I thank Puneet and Rob for their long encouraging conversations and enthusiasm towards my work.

Lastly, I thank my family and guru for cheering me on and always rooting for my growth.

Declaration

I, Shringi Kumari, declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References. Some chapters showcase collaborative work and they are clearly presented as such.

Some of the material contained in this thesis has appeared in the following published publication papers:

Shringi Kumari, Christopher Power, and Paul Cairns. "Investigating uncertainty in digital games and its impact on player immersion." *Extended abstracts publication of the annual symposium on computer-human interaction in play*. 2017.

Shringi Kumari, Sebastian Deterding, and Jonathan Freeman. "The Role of Uncertainty in Moment-to-Moment Player Motivation: A Grounded Theory." *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. 2019.

Shringi Kumari, Sebastian Deterding, and Gustav Kuhn. "Why game designers should study magic." *Proceedings of the 13th International Conference on the Foundations of Digital Games*. 2018.

Shringi Kumari*, Cristina Guerrero-Romero*, Sebastian Deterding and Diego Perez-Liebana. "Studying General Agents in Video Games from the Perspective of Player Experience." *Artificial Intelligence and Interactive Digital Entertainment Conference.* 2020.

Alice Pailhès, **Shringi Kumari** and Gustav Kuhn. "The Magician's Choice: Providing illusory choice and sense of agency with the Equivoque forcing technique." *Journal of Experimental Psychology.* 2020.

Chapter 1

Introduction

"*Making games combines everything that is hard about building a bridge with everything that is hard about composing an opera. Games are operas made out of bridges.*"

— Frank Lantz (Lantz, 2014)

As game designers and researchers we can empathise with the quoted sentiment. We find ourselves constantly hunting for physical or abstract tools which can make our game architectures sing. We incessantly scrutinize our craft (Juul, 2010a, 2011), study the players (e.g. (Bartle, 1996)), see Chapter 2 for more) and look for inspirations (e.g. (Barlow, 2016)) to inform the total artwork of games.

Game developers draw ideas from everywhere (Schell, 2014). We find inspiration in a variety of sources from personal loss (*That Dragon, Cancer* (Numinous Games, 2016)), politics (*Balance of Power* (Crawford, 1985)), crime (*L.A. Noire 2011* (Team Bondi, 2011)), curious incidents (*Kholat* (Pro, 2015)), graphic novels (*Florence* (Mountains, 2018)), folk art (*Okami* (Clover Studio, 2006)), or mythology (*Jotun* (T. L. Games, 2015)) to fields like astrology (*Astrologaster* (Nyamyam, 2019)), architecture (*Monument Valley* (Ustwo Games, 2014)), botany (*Botanicula* (Amanita Design, 2012)) and so on. However, most of these inspirations are unique in their application and don't follow a traceable common technique (which is expected in order for them to produce unique games). The inspirations are often applied to a game's theme, message or art style, which in turn informs the game mechanics and rules. For example, in *Papers, Please* (Pope, 2013), the game designers drew on the world of bureaucracies in totalitarian regimes, immigration, and passport inspectors. The ever-changing regulations and looping real-world tasks of these officers in turn influenced the rules, systems and mechanics of the game. Such a process of taking inspiration from a particular area of interest and then handcrafting a game around it mostly benefits a single game's design or at best serves as a piece to be studied. They do not add up to more generic tools to apply inspirations from other fields.

As the games industry is evolving, it is becoming harder to define 'what a game is' (Ballou, 2019; Juul, 2018) or approaching game design in a unified way (Lanier, 2019). Even though game designers have tried to learn more rigorous general principles from other artistic practices, for example, characterisation, plotting, and dramatic arcs from literature and film and staging from theatre and film set design (Nguyen, 2017; Stemm, 2016; Stuart, 2016; Zukowski, 2018); these learnings are often done on a case to case basis without testing the impact of the applied techniques on player experience. They never really get into the nitty gritty of game design or cater to the diversity in games or players. As games are becoming more varied, so are game development processes and constraints (New York Film Academy, 2014). As a result of this much welcome diversity, the player spectrum is now spread between commuters tapping on their smartphones for a couple of minutes to professional players watched by thousands in an Olympic stadium (Baker, 2019). A game not only needs to fulfil its expressive goals but also cater to the many moving parts that are being influenced by the changing dynamics of the players and the industry.

Game design plays a pivotal role in keeping the game glued together. One fundamental aspect that game designers are seeking inspiration for is finding ways to elicit particular experiences. Evoking player experiences can be an important goal that kick-starts the game design process. For instance, the prime focus of *Florence*'s (Mountains, 2018) game designers was to foster players' emotional exploration instead of pushing them to achieve goals (Findling, 2018). Since game design often revolves around desired player experiences, it is not a surprise that player motivation and player experience are extensively studied in research and industry (see Chapter 2). One of games research's goals is to make it easier for designers to discern important pillars of player experiences (e.g. (Rigby & Ryan, 2007)). However, existing research focuses on theory and largely fails to translate theory into applicable techniques to reliably craft particular player experiences (Kultima, 2018). It rarely delves into the exploration of granular, moment-to-moment gameplay level player experiences to be able to create methods to impact it. More specifically, games research lacks investigation of the mechanisms that motivate players to engage with a game on a 'moment-to-moment' (m2m) basis.

"[Gamers] want to be swept up in the moment of play (Costikyan, 2013)". Even though there isn't much research on m2m gameplay, within the design community there is a huge emphasis on this m2m experience of the player (EuropeOG, 2015; Sivak, 2012; Swink, 2007b, 2009). M2m terminology is used to explain the interaction at a snapshot in time as opposed to the

overarching goals of the game. It focuses on making the immediate gameplay experience from one second to the next align with the designer's intent, thus keeping players involved and wanting to continue.

Uncertainty as an Important Moment-to-Moment Player Experience

Uncertainty shows up as an important experiential factor in literature and has been recognised as a key ingredient of engaging gameplay (Caillois, 2001; Costikyan, 2013; Johnson, 2018; Power et al., 2019). However, it has not yet been studied at the m2m level.

In his early typology of play, Roger Caillois (2001) famously describes the relation between *alea*, chance-based play, and *agon*, skill-based strife, observing that either would lose its appeal if it lacked the 'fitting' kind and degree of uncertainty. A great number of game designers and scholars have since reiterated the importance of 'well-balanced' uncertainty for a good player experience, and diversely tried to identify different kinds or sources thereof (DeKoven, 2002; Golman et al., 2015; Juul, 2011; LeBlanc, 2006; Malone, 1982; Salen & Zimmerman, 2004). While practitioners and researchers have proposed various types and factors of game uncertainty, there is little work explaining aspects of exact working of uncertainty as to *when* and *why* it becomes motivating for players, especially on a m2m level.

It is argued that uncertainty is one of the main factors that fosters human curiosity (Shin & Kim, 2019; Wilson et al., 2005). This is because curiosity functions as a coping mechanism for resolvable uncertainty (Shin & Kim, 2019). Berlyne and other psychologists have extensively studied the fundamental role of curiosity in motivation. It is seen as one of the main drivers second only to appetite or sex (Greenberger et al., 1967). It is perplexing that with curiosity holding such a front and center role in motivation, curiosity and its link to uncertainty have barely been studied (especially empirically) in games. The little work that there is regarding curiosity in games follows some specific models while disregarding other base models without much reasoning (To et al., 2016). Within games research, other than scattered guesses at the relationship between uncertainty and curiosity, we don't see the linkage systematically investigated. We suspect this is because player experiences like uncertainty have not been studied with respect to 'micro-level' m2m gameplay where the connections might be more apparent. For both uncertainty and curiosity, existing research chiefly relies chiefly on 'summative post-hoc' memories of gameplay as opposed to probing into instances of gameplay through

gameplay-video recalls or taking observational notes during gameplay. It has not investigated how to invoke the uncertainty that keeps players motivated or when this uncertainty makes players curious. It is not just curiosity and uncertainty though that are linked in human motivation literature. Both belong to the cluster of so-called epistemic emotions which are emotions that are linked to acquiring or having knowledge such as interest, surprise, trust, feeling of knowing, feeling of anticipation amongst others which are closely connected and inform each other (Carruthers, 2017; Meylan, 2014; Morton, 2010; Pekrun et al., 2017). Not only do we need to start exposing such linkages when it comes to games, but also explain ways to elicit motivating epistemic emotions in games for practical application.

Role of Choice and Decision Making

An important nexus of curiosity and uncertainty in games are choices or decision-making. Perception of free choice and ability to make impactful decisions when faced with options is linked to curiosity towards the outcome of one's choice (Berlyne, 1950; Shin & Kim, 2019). Choice and thus decision making are fundamental to gameplay and gameplay enjoyment. Sid Meier popularly says, "Games are a series of interesting decisions" (Meier, 2012). This is backed by other designers and a considerable amount of research in player motivation (DeKoven, 2002; Golman et al., 2015; Juul, 2011; LeBlanc, 2006; Malone, 1982; Salen & Zimmerman, 2004). What we do not fully know is what makes these decisions interesting as the game unfolds for the player on a m2m basis. In human motivation studies it is found that participants provided with choice in topics show greater curiosity regarding the topic than participants who do not have a choice (Schutte & Malouff, 2019). We think that choice creates a sense of agency and freedom or autonomy in games (Ryan et al., 2006). Players become aware of their agency when presented with decisions which allows them to engage in the thrill of making risky/strategic/intelligent/winning choices (Fendt et al., 2012; Thue et al., 2011).

How choice relates to curiosity and 'optimal' uncertainty is less well understood. Specifically, we know little about how to design for curiosity and optimal uncertainty given that choices offered to players always run into the pragmatic limits of game development. The question of finding ways to help game designers elicit these m2m player experiences remains far from answered. Psychology is an evident lens to study the player's mind for game design insights and game designers like Raph Koster have looked at the use of cognitive theory concepts in game design (Koster, 2013). Other creative fields like stage magic also rely on their firm knowledge of human cognition for

practical design inspiration and to formulate principles that lend to stage magicians' design toolkit (Kuhn et al., 2016). This is where the needs of practical game design meet that of other creative fields. This is the main reason we look for inspiration in other creative fields that have perhaps faced similar challenges and effectively utilised existing knowledge in cognitive psychology for our enquiry to benefit from.

Stage Magic as Design Inspiration for Evoking Epistemic Emotions

We[1] want to understand and evoke uncertainty and related epistemic emotions in games. Stage magic which refers to illusions performed on stage for a live audience, heavily draws on epistemic emotions like curiosity, surprise and their catalysts like suspense and mystery (Ortiz, 1995, pp. 182–217). Ortiz and other magicians have explicitly recognised the important link between magic and epistemic emotions (Ortiz, 1995; Ozono et al., 2020; Vidler & Levine, 1981). The drama of a good magic performance orchestrates curiosity, uncertainty and anticipation in a tight loop (Ortiz, 1995).

Successful conjuring requires a firm understanding of human cognition (Kuhn et al., 2008) which is the core at which a game designer's needs meet that of a magician. For perfecting a magic performance, magicians test their theories and revise them until they elicit the experience they want people to have. Magicians have dedicated years of such testing between generations to learn about the human mind. Magic as a scientific field is in the process of testing these psychological theories and making these principles viable for application in other fields like that of wellbeing, education and perhaps games (Bagienski & Kuhn, 2019; Kumari et al., 2018; Vidler & Levine, 1981; Williams & McOwan, 2014). Furthermore, existing research argues that the science and art of stage magic share uncanny similarities with interaction design (Tognazzini, 1993) and thereby possibly with games. This is one of the reasons why magic can potentially lend games a much more precise point of entry to the secrets of the human mind that game researchers and developers wish to investigate.

When it comes to games, amongst others, designers like Jeff Howard (Howard, 2014) and Jennifer Scheurle (Scheurle, 2018) have investigated different aspects of magic for practical inspiration. 'Magic' in games can mean multiple things: 'magic systems' as in rule systems for handling fictional game

[1] Throughout the thesis, in saying 'we' the researcher primarily refers to herself, the reader and acknowledges the supervision team for the guidance provided to her in doing the PhD.

worlds (Howard, 2014) ; forms of magic as inspirations for the world theme of a game (*Magic: The Gathering* (Garfield, 1993)); ritual magic as used in the analysis of social and psychological processes and designs of role-playing games (Harviainen & Lieberoth, 2012) etc. That said, stage magic with respect to games is by and large an unexplored discipline. Stage magic tricks use honed techniques to induce epistemic emotions that could be especially interesting for similar interrogation in games. We suggest that games have much to learn by taking a closer look at how magicians choreograph for creating curiosity, surprise and uncertainty. Amongst other methods, they do so by creating conflicts in viewer's expectation of the outcome by violating existing causal expectations (Kuhn & Land, 2006) or creating a dilemma by presenting illusory choices (Kuhn et al., 2008, 2020). In general, magic and games try to build up an illusion where anything is possible within the rules established by the magician or game designers. However, behind the illusion lies a set of mechanics with pre-scripted maneuvers. For instance, a magician presenting a choice by saying "pick a card, any card" can be compared to games when they ask the player to pick between options, but the eventual outcome is already scripted like in the stage magic trick. The technique of 'forcing' (creating the illusion of choice where there is none) could be a great inspiration for game designers when they want to afford player choices that are motivating and evoke epistemic emotions connected to uncertainty while there in fact being no 'real' choice at all.

Like magic tricks, games limit their audience's choices, and like magicians, developers don't want players to see these limitations (unless intentional) when they are immersed in the game world (Nitsche, 2008). One of the most powerful and versatile tools in a magician's toolkit for manipulating audience choices is 'forcing'(Kuhn, 2019). This is an umbrella term for techniques and tricks that allow magicians to covertly influence spectators' choices or outcomes of the choice (Kuhn et al., 2008; Pailhès & Kuhn, 2019). The basic use of forcing is to influence a person's choice without them being aware of it (Annemann, 2011; Shalom et al., 2013), creating an illusion of choice and thus perceived autonomy where in actuality there is none.

Forcing and Equivoque

Forcing principles are divided into two major categories: *Choice* forces and *outcome* forces (Pailhès & Kuhn, 2019). *Choice* forces refer to forces where magicians directly influence and manipulate the spectator's choice. For instance, magicians can increase the visible exposure of a particular card making it a more salient option to pick (Olson et al., 2015). The more commonly used forces fall under the category of *outcome* forces. These forces

rely on manipulating the outcome of the choice, rather than the choice itself. Here, the magician doesn't restrict the choice and the audience member has a genuinely free choice to make. However, contrary to their belief, their choice has no impact on the outcome of the trick.

A prime example of *outcome* force is the principle of *equivoque*, also known as 'The Magician's Choice', where magicians give a genuine free choice to the audience but devise the next steps of the trick in a way that any choice leads to the same result. It is said to be one of the strongest tools mentalists (magicians who perform mind reading tricks (Landman, 2013)) can use to force an outcome (Banachek, 1998, p. 22). *Equivoque* heavily relies on using semantic ambiguity when phrasing a choice (Pailhès et al., 2020). The magician predetermines a target object (often a card) and provides the spectator with a set of so-called free choices. The choices are phrased and framed in a way that each decision leads to the same outcome. For example, the magician deals three cards on a table and asks the spectator to *touch* two of them. The magician knows they want the audience member to end up with one particular card. The performer asks the spectator to *touch* some items among others, but simply always removes the items they do not want the spectator to have. The word *touch* is ambiguous as to its results: discard the card touched, or keep the card touched. Had the magician asked to *pick* or *hold* the card, this necessary ambiguity needed for *equivoque* would have been lost. *Equivoque* is found to produce a strong illusion of agency over the outcome, as the spectator fails to register how the magician selectively and variously interprets their decisions (Pailhès et al., 2020).

Human beings frequently accept such small disparities and they go unnoticed in our daily lives (Erickson & Mattson, 1981; Kahneman, 2002, pp. 449–489). We gladly perceive ourselves as the causal agent, even when our actions do not directly impact the outcome. For instance, in *Choice Blindness* experiments, participants fail to detect the mismatch between their original choice and a secretly forced outcome; they readily produce post-hoc reasons why they opted for a selection they did not in fact choose (Hall et al., 2010, 2013; Hall & Johansson, 2008; Johansson et al., 2008). We simply accept outcomes as a doing of our decision making. We suggest that game design and games research can benefit from looking into specific techniques like *equivoque* to cross-reference and gather new insights.

We can apply *equivoque* to choices in games to see if these psychological principles liberally used by magicians elicit motivating player experiences in game worlds. Such mapping of principle from the field of stage magic or any other creative field to games for design inspiration has not yet been

undertaken by research. While games already have illusory choices, one can expect *equivoque* to have a fruitful impact on drastically reducing narrative branches to linear structures by including fake choices that don't even need a reason to converge the branches. More importantly, *equivoque* can possibly be used in a narrative game to confront the players with a decision via an illusory choice and see if this creates motivating uncertainty that accompanies decision making. Following magician's *equivoque* we can expect player's to omit the inconsistencies that lead different choices to identical outcomes. This could allow players to experience an illusory sense of control over the outcome which is conducive for feeling motivating decision uncertainty regarding the choices presented. There is a wide opening for games research to use stage magic principles such as *equivoque* to discover, build and test design tools for arousing player experiences.

This work of research is primarily motivated by game designers' interest in finding ways to help designers elicit important player experience. As discussed, to accomplish this, game design often takes inspiration from other fields in largely singular, non-transferable ways. In this research, we explore whether we can apply the principles and techniques of other creative fields like stage magic to game design in a more generalisable fashion, and do so for one particular player experience, uncertainty. Thus, the work we present is set out to tackle this nebulous job by: (1) understanding uncertainty as a crucial m2m motivation for players, and (2) exploring whether the field of stage magic offers principles and techniques that can be used to elicit said motivating uncertainty in games.

Research Question

In summary, how uncertainty motivates players in their m2m play is an important open question for researchers and designers. Furthermore, how to elicit such motivating uncertainty and related epistemic emotions isn't explored much in games research. Techniques inspired by the field of stage magic can help create illusory choices; the choices can further help in eliciting decision uncertainty through design. Especially, the forcing principle of *equivoque* appears promising to design uncertainty-preserving m2m choices in narrative games where game designers are interested in steering the choices in a particular direction.

Therefore, the central question of the thesis is multi-fold in the following order:

RQ1: *What is the role of uncertainty in moment-to-moment player motivation? How can we design for such uncertainty?*

RQ2: *Can the magic forcing principle of equivoque offer design inspiration for evoking motivating decision uncertainty in players?*

Evidently, the question has many largely unexplored terms like *forcing*, *uncertainty*, in fact *stage magic* itself in the context of games is a widely undiscovered field. This makes it apparent that these constructs need further exploration before we attempt to answer the main research questions. Thus, here are some objectives that have been sketched out to tackle the research questions:

Research Objectives

To unpack the role of m2m uncertainty for player motivation, we need to know the present literature in the first place. Thus, Research Objective 1 is:

RO1: *To examine the current player motivation literature in order to position uncertainty and related epistemic emotions.*

For this, we conducted focal narrative literature reviews on player experience and motivation (Chapter 2), curiosity and uncertainty outside of games research (Chapter 3), and uncertainty as a player experience in games research (Chapter 4).

These literature reviews reveal that there is little empirical knowledge about how uncertainty motivates players m2m. This leads us to Research Objective 2:

RO2: *To explore when and why uncertainty becomes motivating in m2m gameplay.*

We opted for a qualitative method, namely constructivist grounded theory (Chapter 4) for answering this objective. The study uncovered a strong link between uncertainty and curiosity. Furthermore, it highlighted the important role of decision making uncertainty.

To devise tools for designing for motivating uncertainty that could be taken from the field of magic was our next Research Objective:

RO3: *To survey the field of stage magic for relevant game design inspiration, especially with relation to eliciting epistemic emotions.*

To achieve this, we conducted a literature survey of the field (Chapter 5) uncovering ways to elicit epistemic emotions. From the review, we suspect that *equivoque* can help elicit decision uncertainty in games. Research Objective 5 tests this:

RO4: *To explore if equivoque can be applied to invoke decision uncertainty in games.*

We conducted a more detailed review of *equivoque* (Chapter 6) to explore its applications. Further to that, we conducted a series of three empirical studies (Chapter 7) into whether and how *equivoque* can help elicit decision uncertainty in games.

Research Approach And Methodology

This research uses a mix of research methods that answer to the needs of particular objectives. Primarily, it uses online quantitative between subject studies to evaluate if uncertainty can be elicited using *equivoque*. Online studies allow us to recruit diverse participants and maintain ecological validity. This comes at an expense of not being able to control the play environment as strictly as in a lab study (Cairns & Cox, 2008). Across the studies, we didn't want players to feel pressured into playing in a certain way and feeling as if they are being monitored. We placed attention and comprehension checks in place to avoid collecting data from players who skipped crucial steps of the study. We used such quantitative methods as we had specific hypotheses we wanted to test.

Where we did not enter a topic with a fixed hypothesis but wanted to generate theory, we used qualitative methods like constructivist grounded theory (Charmaz, 2014) to explore m2m player motivation and find uncertainty as a key player. Mixed qualitative methods of data collection (diary entries, video recall, semi-structured interviews) allowed us to collate data from different perspectives. In terms of recruitment, we were very careful about diversity and tried to recruit people across demographics like age, gender, play preferences, play behaviour, occupations and ethnicity.

Lastly, the thesis spans several disparate fields (stage magic, psychology and games), therefore required investigation of colossal and entangled topics. We did not want to fall prey to wearing blinders and starting the investigation with the first fitting model without making an organised effort to find suitable inlets. To remain rigorous yet incisive, topical literature surveys are

in order. For instance, to look at epistemic emotions we primarily concentrated on literature surrounding feelings of uncertainty and curiosity, and for looking at stage magic we used the lens of epistemic emotions. This allowed us to analyse only those stage magic principles that have been documented with respect to invoking epistemic emotions.

Structure of the Thesis

This thesis moves between involved yet separate topics (player motivation, uncertainty, epistemic emotions and stage magic). We work through a specific literature related to an individual topic and bundle of studies at a time. We do so to avoid front loading the reader with all the information. In Chapter 2, we discuss the work done in player motivation by researchers and developers and draw tentative links between uncertainty and player motivation. We identify that despite emotions being integral to human motivations, its exploration in games research with respect to motivations is restricted and pre-empirical (not testing the theories or verifying their relations with other game elements or other player experience constructs). In Chapter 3 we therefore throw light on curiosity and related epistemic emotions as understood in psychology. We identify relations between curiosity and important player experiences like uncertainty, surprise and interest. We keep this chapter brief to avoid getting derailed in various branches of psychology; instead the main aim of this chapter is to make the reader acquainted with these terms and find links between uncertainty and motivation. In Chapter 4, we explore existing work in uncertainty in games and identify the gaps in the field. This is accompanied by a mixed-data grounded theory study that inspects m2m player motivation and finds that uncertainty plays a central role. We identify sources of uncertainty and provide a taxonomy of seven uncertainty types based on these sources. We also identify which motivational constructs uncertainty communicates with, identifying *when* and *why* uncertainty becomes motivating. From our grounded theory analysis, curiosity comes out as one of the main motivators around uncertainty. Of the different kinds of uncertainty, we single *decision uncertainty* for our interest in line with the definition of games as a series of interesting decisions (Meier, 2012). We identify two salient features for players to feel decision uncertainty: (1) they feel that there is a genuine free choice to be made, (2) they feel that their decision will have an impact on the outcome.

Our research objective to give designers tools to elicit motivating uncertainty makes us evaluate different creative fields where we can find design inspiration. In Chapter 5, we establish why stage magic is a rich source of

knowledge for game designers. It also applies lessons learnt in psychology in a creative format. We make a case that magicians are experts at invoking epistemic emotions in their audience. They have applied design principles that use mystery, conflict and tension to create required curiosity, uncertainty and anticipation for their conjuring to be successful. We draw parallels with game design to showcase the overlap and highlight principles like perceptual causality and forcing that can be used to create surprise and the illusion of choice respectively. Both are extremely vital for games.

In Chapter 6, we zero down on the principle of *equivoque* as an apt vehicle to maintain *decision uncertainty* when designers want to steer player choice in particular directions. Here, we explain the workings and types of *equivoque* and explain how they can benefit game narratives. Subsequently, in Chapter 7 we test our theories with 3 studies on *equivoque*. The first is a lab study in partnership with magic researchers to establish that *equivoque* can create an illusion of choice which feels real to people. The next two studies apply *equivoque* to a narrative game to test if other than creating a feeling of choice and perception of impact, equivocation also creates decision uncertainty. The first of these two studies is a porting of *equivoque* to games and a test at a single decision point. The following study investigates if *equivoque* is sustainable over multiple choices: we test if *equivoque* elicits decision uncertainty if the illusion is repeated over and over (in this case four times) or is interleaved.

Finally, in Chapter 8 we bring together the individual learning from each of these chapters and discuss the contributions, limitations and ideas that we have for future work in the field. In this chapter, we use our findings to position our work in the universe of game research and development. Additionally, we shed light on the contribution we have made in translational work in games research and HCI at large; both in translating knowledge from theory to practice and translating knowledge from one creative field to another. We also provide a reflection on our methodology and process of answering our research questions in totality.

Note: *We are enthusiastic about showcasing our findings and insights. We hope our work (through the spheres of uncertainty, curiosity and stage magic) is interesting, inspiring and educating for the readers.*

Chapter 2

Why Do Players Do What They Do?

Introduction

In this chapter and the next, we aim to find relations between uncertainty and existing player motivation work to find information that addresses our first Research Question and find theories that our research can further investigate.

RQ1: *What is the role of uncertainty in moment-to-moment player motivation?*

More specifically, these chapters aim to address the first Research Objective

RO1: *To examine the current player motivation literature in order to position uncertainty and related epistemic emotions.*

Video games are popular and their popularity is only rising across demographics (May, 2020). It is becoming increasingly prevalent to ask questions about games and game design from the player's perspective. Why do players engage in games and spend their time in game universes? What motivates players to do what they do in a game world? We think that continuing the exploration of answers to questions like these can help designers in crafting desired or intended experiences. This is perhaps why the field of player motivation and player experience (both in the games industry and academia) is constantly expanding (Desurvire et al., 2012; Hodent, 2017).

Games can be conceived from multiple starting points, where the inspiration could come from a doodle (*Angry Birds* (Rovio Entertainment, 2009)) to wanting to tell a personal story (*Cibele* (Freeman, 2015)). A common way to design a game is to define and describe the game itself: its features, mechanics, rules, tokens and so on. A different, increasingly prevalent approach is to start from the player and define what *experience* the game in question aims to evoke (Hagen, 2011). Jenova Chen, game designer of the acclaimed game *Journey* (Thatgamecompany, 2012), explains that the inception of the game came from wanting the players to have an emotional experience. He says, "We wanted to make a game that makes you feel somewhat lonely and small, but [where] you have a sense of awe toward the

mystery behind this game" (Chen, 2013). This is just an example of the way in which many game designers today approach design, where the starting and even the most important factor is the player's experience. We think an important investigation is the relation between these experiences and the design of game elements. For example, not only what role does uncertainty play in motivation but how do we arrange game elements to elicit the feelings of uncertainty. For now, we focus on the first half of the problem.

One, if not the most important experiential quality game designers aim for is that players are motivated to play. Video games tap into motivational processes as well as or in some cases better than traditional forms of media entertainment (Ryan et al., 2006). Players' motivations amongst other things vary with their phase or stage of engagement with a game: before starting a game, during the game, at the end and after the game. They vary from genre to genre, platform to platform and to an extent from one player to another (Tuunanen & Hamari, 2012). While crafting a motivating player experience is important, it is perhaps complex to design for, given experiences as they emerge and shift as a player continues from one moment to another. Researchers have identified the cruciality of player motivation and done a vast array of work in this domain (Juho Hamari & Tuunanen, 2014). Since the inception of video games, scholars have approached player motivation through constructs like challenge and mastery (Denisova et al., 2017; Malone, 1984; Tichon & Tornqvist, 2016), increasingly linked to theories about basic psychological needs like that of perception of competence (for e.g. through game feedback), feeling autonomous and connected with the community (Rigby & Ryan, 2016, 2007; Ryan et al., 2006).

It becomes important to unpack and reflect on what do we count as motivation behind player's actions as the term 'motivation' in itself is broad, multifaceted and contested (Buchenau & Suri, 2000; Cofer & Appley, 1964; Deci & Ryan, 2010; Reeve, 2014, pp. 1–23; Weiner, 2013) and so is player motivation. Instead of illustrating all the aspects of this term, we here will look at their usage within the scope of games. We inspect the intersections where motivation touches upon player experiences that are described as favourable by players: like fun, engagement, flow, immersion, satisfaction etc. (Denisova et al., 2016). As these are emergent qualities which conflate with players' personal trajectory, they simply cannot be mapped to individual game components (Hagen, 2011), however we wish to find notable game patterns with respect to uncertainty and m2m motivation. Since player motivation and player experience are themselves so multidimensional, the literature in the field is expectedly more like a disjointed mosaic missing pieces than a coherent expanding picture which makes it hard for us to find

neat links or gaps between player motivation and uncertainty. We start with taking a brief look at psychological constructs related to human motivation to be able to organise literature about player motivation with respect to our research.

A Brief Look at Psychological Constructs related to Motivation

The question 'why do players do what they do?' according to us, must be importantly linked with 'why do people do what they do?' For this reason we take a brief look at motivation in the field of psychology. This will help us systematise what we know about player motivation and what we still need to test or find out with respect to uncertainty. As said above, motivation is a deeply contested concept and does not have a general grand theory. This is owing to the complex nature of human beings (Baumeister, 2005, 2016) and clashing assumptions about the nature and dynamics of motivation amongst researchers (Reeve, 2016). To answer what constitutes motivation and thus player motivation we refer to some existing work.

Needs (biological, psychological or implicit), cognitions (goals, plans, expectancies, beliefs etc.), emotions, and external events (feedback) are commonly identified as the major processes that constitute motivation and might be giving behavior its energy and direction (Reeve, 2014). Researchers have evolved and added needs for belongingness, esteem, self-actualization (Yang, 2003, pp. 175–255), competence and thriving (R. W. White, 1959) on the two basic motivational needs of survival and reproduction (Aunger & Curtis, 2013). This has been taken up by the theory of intrinsic motivation formulated by Deci and Ryan which has seen its application in games (Deci & Ryan, 1980; Ryan et al., 2006). On the other hand, emotion as a source of motivation is typically divided into basic emotions, self-conscious emotions and cognitively complex emotions (M. B. Arnold, 1970). The feeling of uncertainty falls into the group of epistemic emotions which are emotions related to acquiring or having knowledge i.e. emotions humans feel when they learn, adapt, test, explore, discover and find new information (Brun et al., 2008, Ozono et al., 2020). We will discuss these emotions in further details in the next chapter with respect to player motivation. This chapter and the next will continue to inspect needs, cognitions, emotions and external events with respect to player motivation.

Baumeister (2016) essentially defines motivation as 'wanting', as a suggestion to simplify motivation being classically defined as an internal

process that energises, directs and sustains behaviour. Reeve et al. (Reeve, 2016) point out that 'wanting' requires a preceding knowledge. However, Wright and Reeve et al. (Reeve & Cheon, 2014; J. S. Wright & Panksepp, 2012) add that there is an explorative side of motivation that is forward looking. Panksepp calls this 'seeking' (J. S. Wright & Panksepp, 2012).

Relevant to our research, the most direct situational factors that trigger 'seeking' with respect to the motivation (of curiosity) are uncertainty or unpredictability and incongruity (Berlyne, 1962; Boykin & Harackiewicz, 1981). Curiosity triggered by uncertainty is due to a gap in desired knowledge and the need to resolve it (Kagan, 1972). It follows that people 'seek' (are curious) to resolve uncertainty or 'information gaps'. In presence of uncertainty (knowledge gaps), individuals are motivated to eliminate uncertainty regarding information gaps when the benefit of resolving it is perceived to be greater than the cost; in other words the uncertainty is not too high compared to the effort being put to resolve it. This depends on: (1) How important and useful they perceive the information to be (Golman et al., 2015); for instance, information relevant to career aspirations or social relationships is highly valued (Swann et al., 1981; van Lieshout et al., 2018). (2) How attainable the information is for them (i.e., expected availability) (S. I. Kim, 2013). Overall, 'manageable' uncertainty motivates people to 'seek' its resolution. This link between uncertainty and 'seeking' has been explored in games by To et. al (2016) (discussed in Chapter 3). The idea of optimal uncertainty as a motivating factor for players has been discussed by game designers and researchers (Abuhamdeh et al., 2015; Costikyan, 2013) which we illustrate in coming sections.

Reeve suggests that the study of motivation revolves around two perennial questions: (1) What causes behavior? (2) Why does behavior vary in its intensity (Reeve, 2014, pp. 1–23, 2016)? Here, it's important to understand phases of motivated behaviour that transition: Where and why does a behaviour start? Why is behavior sustained over time? Why is behavior directed toward some goals as opposed to others? Why does behavior transition in direction and change over time? And why does it stop? (Reeve, 2014, pp. 1–23). This throws light on a fundamental problem in the motivational analysis of behavior i.e. to understand why a person's behavior varies in its intensity from one moment to the next. This maps with our interest in players' varying motivation in gameplay from one moment to the next. Not only are we interested in what causes a player's actions/behaviour but how and why it changes from one moment to another. Subsequently, what role does uncertainty play in the m2m motivation changes of the player.

As opposed to transitioning motivation i.e. the need to showcase a particular behaviour on a specific occasion i.e. more to do with the 'here and now' are the perpetual tendencies of wanting food, safety or sex (Maslow, 1943). This brings us to the *state* vs. *trait* debate in motivational studies. *Trait* motivation is more of a constant property of a person whereas motivational *states* can be seen as an interaction between the current situation and a person (Bolles, 1980). For example, someone may be very hungry now because they haven't eaten for a day (*state* motivation), or someone may have a strong appetite in general (*trait*). Reeve (2016) insists that "motivation is always a state," arguing against motivation as an enduring constant. He proposes that it is more useful to analyse conditions that can create internal conditions triggering motivational states, this is what we are also interested in. When we look at games, this is an extremely important argument, as a game's environmental state changes all the time, arguably impacting the player's motivational states. However, the majority of the current literature in player motivation focuses on behavioural typologies derived from traits (Tuunanen & Hamari, 2012). Also, literature on motivation further emphasizes the transformational nature of motivational potentials over time and across situations (Hidi & Renninger, 2006; Jenkins, 1987). Again, from the perspective of games, this aspect of motivation is extremely important as games trigger the transformation of motivation by being interactive and responsive.

This section provides a broad and somewhat crude and partial overview of human motivation. However, it shows that the psychological literature in motivation deals with *state* and not *trait* based models and recognises needs, cognitions, emotions, and external events alike as motivations. It places emotions (like epistemic emotions) as a source of motivation and also relates motivation with 'seeking' or forward looking. This starts to show us that the 'emotions' of uncertainty (an epistemic emotion) could be motivating for people to 'seek' resolution and trigger the 'need' to fill information gaps. We will use 'needs' and 'emotions' as some of the parameters to analyse existing player motivation literature.

We suspect that the answer to 'why do players do what they do' must be multifaceted. A number of motivations, needs, emotions and experiences must interlink and impact players' reasoning to pick, play or discontinue a game. We hope to find which of the existing work addresses m2m motivation and links with uncertainty and related emotions (e.g. emotions of curiosity and interest) around knowledge gaps and the need to fulfill knowledge gaps. We acknowledge that player motivations are diverse so we cast a broad net to

find links between different player types (based on existing typologies) and their motivations.

In the next sections we will discuss existing player behavioral models and the motivational reasoning linked with that. We suspect these player typology models that interlink with player motivational types will give us insight into 'why players do what they do' on an m2m basis but also show how much the role of uncertainty has been analysed as a reason for players' motivation to play. Existing work in player motivation spans different game genres and playing styles. Here we present only the current major pieces of the existing literature that add information to our research objectives.

Player Typologies and Experience Models

We look at some select player typologies to see how researchers have explained and categorised behaviour. Researchers and designers have constructed player typologies to categorise player behaviour, but in doing so they also explain the reasoning behind player behaviour. This reasoning behind behaviour, seen from what Reeve suggests, must be the player's motivation that gives their behaviour its energy and direction (Reeve, 2014). From a motivational study perspective, we are interested in that reasoning more than the typology itself. We discuss the most prominent typologies that contribute unique methodology of categorisation and results.

Caillios' Patterns of Play

One of the oldest typologies for play was offered by Roger Caillois (2001, 2006), who described four different forms of playful behaviour which also serve as play style patterns. *Agon* is the Greek word for contest and was used to describe games of challenge, meaning games that involve a direct conflict or competition. *Alea* is the Latin word for dice and describes games of chance and randomness. *Mimicry*, similar to the biological term, is used to describe play as someone or something else, which includes role-playing, play acting and dress-up. *Ilinx* is the Greek word for whirlpool or vertigo (i.e., sudden shock). This is used to describe games with a visceral impact. Caillois also classified games along an activity dimension ranging from structured *ludus* (i.e., a rule-based activity) to unstructured *paida* (i.e., spontaneous activity). Caillios made it clear that this was not an exhaustive categorisation system of play but an exploration. Our analysis of this categorisation speculates that players 'seek' or are motivated towards: (1) challenge (*agon*) to test their competence; (2) the outcome of chance (*alea*) to resolve their uncertainty around random outcomes, for example, a player rolls a die and then is

uncertain about the outcome but excited to see where the die lands (resolution of uncertainty). This category by Caillois and our analysis of it is much in line with Sutton-Smith's 'play as fate' rhetoric of play where he refers to uncertainty around games of chance and gambling (Sutton-Smith, 2009); (3) entering the role of someone else (*mimic*); (4) being taken by surprise and encounter the unexpected (*ilinx*). With identifying *alea* and emotions related to unexpectedness and surprise, Caillois was one of the first to link uncertainty and other epistemic emotions in games with enjoyment.

The main shortcoming of Caillois' system and systems built on top of it (Bateman 2009, p.64; Bateman and Nacke, 2010) is that they do not say which of these behaviours and related motivations are most prevalent in players and why. It does not compare or link these four factors with each other (do they overlap?) or explain its varied degrees of effects on the player. That is, it does not say much about the moment to moment nature of motivation and its relations with game states or arrangement of game elements. As Caillois himself points out, these four dimensions are not complete in themselves. It is limited in perspective as is drawn out of pure personal observation and speculation and we do not know how these behaviours impact other player experiences. The model describes the player's activities with some motivational insights but doesn't say how we should design for such behaviour or motivation which is one of the goals of our research work. It also does not tell us if the player's states beyond the game i.e. the context in which they are playing impacts their behaviour or motivation. Lastly, it doesn't explicitly discuss player emotions while they demonstrate these play patterns.

This system gives us our first insights into the role of uncertainty related to chance (*alea*) and the motivation to seek results of the chance. It also highlights the role of challenge (*agon*) and related feeling of competence (an epistemic emotion) which lines with factors of intrinsic motivation to continue an activity (Deci & Ryan, 2010). Finally, it tells us that players enjoy the unexpected 'shock' (*ilinx*) which we think feeds into the feeling of anticipation and surprise that is another epistemic emotion that motivates in terms of knowledge seeking. These are important insights for us to further investigate.

Hearts, Clubs, Diamonds, Spades

Richard Bartle's (2004, 1996) typology explains player behaviour by categorising Multi-User Dungeon (MUD) players into four groups: *Killers*, *Achievers*, *Socializers* and *Explorers* based on data collected from MUD players.

Killers are players who like to attack and trouble other players by playing the 'evil' player role. *Achievers* are players who want to gain the most points, climb all leaderboards, finish all levels etc. for prestige. *Explorers* like to investigate and find everything about the game like hidden paths, character backgrounds etc. *Socialisers* play the game for its social aspect and the game serves as a platform to meet others in-game or outside. With these types Bartle explains player behaviour and he acknowledges that the ability to continue acting in these directions motivates these players to play, for instance, *Killers* are motivated to engage with the game to avail the opportunity to behave like *Killers*. This falls in line with *trait* based motivational idea of motivation being a perpetual tendency i.e. *Killers* have a perpetual tendency to attack and trouble other players. In terms of uncertainty, we already see that the *Explorer* tendencies link with 'seeking' behaviour of filling information gaps and *Achiever* tendencies link with achieving results including resolving information gaps. Exploration lines up with the epistemic emotions of acquiring knowledge by resolving knowledge gaps about the world. In our analysis this ties with the idea of wanting to resolve 'manageable' uncertainty (see above section) and the curiosity to resolve it.

With this early model, Bartle did not acknowledge that these tendencies can overlap (i.e. an *Explorer* can be an *Achiever*) or there can be more nuanced subtypes to each category based on the reasoning or motivation behind that behaviour. Moreover, it didn't consider variation in behaviour and that motivations can change over time. To address this, he later added a new axis *Implicit/Explicit* to his first model (Bartle, 2005). *Implicit* acknowledges players acting without actively thinking about their actions, while *Explicit* recognizes players' intention to act in a certain way in the game. The *explicit* side of the axis acknowledges that the player acts based on some trigger in the environment whereas the *implicit* axis suggests the idea that players themselves don't know what their motivations are. Although this doesn't exactly say 'why players do what they do' but it starts to acknowledge the role of *states* based motivation in behaviour i.e. motivation change based on triggers in the game environment. Furthermore, his later model described how players take different sequences in transitioning from one type to another. However, these stipulated shifts in motivations are tailor made assuming that players have a certain pre-designed path of behaviour. Adding this extra dimension adds four more player types, giving each parent category a sub-type. This addition has not been deeply tested on its own or with respect to other player experiences making it less robust beyond a theory.

As acknowledged by Bartle, these player types don't lend themselves to all kinds of games (Kyatric, 2013) or platforms (e.g. VR). This theory has been applied by designers. However, for over a decade it was not quantitatively tested or contested throwing little light on the rigor or limitations of the model. While designers have adapted it to their benefit, the literature itself doesn't provide tips to design for these behaviours and underlying motivations and test them with respect to other player experiences. It also does not account for the player's state before or after picking the game. That said, Bartle's model starts from a *trait* based system to acknowledging the *state* based motivation that directs behaviour. This is one of the first steps in looking at moment to moment motivation change in players based on game states. His *Explorer* type suggests that players do want to resolve uncertainty or 'information gaps' in the environment by exploring to seek resolutions even though emotions of uncertainty or other emotions are not directly discussed.

Motivation Types by Nick Yee

Nick Yee (2019a, 2016) developed a typology based on motivations. He developed a model of motivational types made up of various strongly expressed components instead of unitary player types, based on a large scale survey by massively multiplayer online role-playing (MMORPG) players. The questions he used were drawn from existing work in player motivation and motivation psychology (Bartle, 2004; Hunicke et al., 2004; Lazzaro, 2004; S. Rigby & Ryan, 2007; Sherry et al., 2006). Yee has continued to work on the typology and Fig. 1. shows the current iteration of his motivation matrix of 12 components from his work at Quantic Foundry (Yee, 2019b), using data gathered from over 400,000 gamers.

Fig. 1. Components based Player Motivational Types by Nick Yee (2019b)

The model digs into the motivation behind player behaviour and both expands and contradicts Bartle's player types. For instance, behavioural characteristics of Bartle's *Killer* type are split between the motivations of *Destruction*, *Competition* and *Challenge* subcomponents. Yee moves away from strict player types and explains that motivational components can overlap in an individual: the same player can have different motivations. That said, this model does not address change of motivations based on *states* i.e. it throws no light on behaviour triggered by changes in the game environment. Yee reports the motivation of *Discovery* as an urge to explore and experiment. We suspect this to be similar to Bartle's *Explorer* type where players 'seek' to find more information about the game to resolve knowledge gaps (uncertainty). His *Excitement* component points at the player seeking surprise and is motivated to perform fast paced actions. Later in the thesis we see how this motivation links with the player's m2m interaction with the game and its connected uncertainty (Chapter 4). Once again we see *Competition*, *Challenge* as motivational components related with players' epistemic feelings of perceived competence that informs their intrinsic motivation (Deci & Ryan, 2010) to play.

Categories like the ones in Yee's and Bartle's models reflect types of player actions and the mechanics and systems of the game rather than explaining what led players' actions themselves. They classify motivation from behaviour in a predefined game space. These models are not talking about underlying needs or emotions as states, but personality traits. They are therefore prone to the issues we discussed earlier of traits as perpetual tendencies of behaving in a certain way, not paying attention to complex situational state-based transitions and differences. While they can help in suggesting to players other titles they may like, from a design perspective, they throw little light on questions like: 'How can we get players into these 12 motivational constructs? Do these motivations transition from one moment to the next within the game and if so how?'

Even when they describe personality traits as stable player preferences to behave in a certain way, what remains unexplained is 'why' players are the 'type' they are or have certain motivation types. Why and when do they act in a certain way? What triggers a change in type? Any such strict categorization might always have gaps as neither can it address all kinds of games nor all kinds of motivation triggers that lead to player's in-game behavioural states. While Yee draws motivational types which are starting to describe the reasoning of the behaviour and shows motivation types like that of *Discovery* he does not explicitly link it with emotions like curiosity and other epistemic emotions that we suspect inform *Discovery.* Similarly, the model discusses

Challenge seeking as motivation but does not link it with the motivational construct of perceived competence that is a component which makes challenges motivating (Ryan & Deci, 2017). A motivational model like this could have touched on player needs and emotions but it mostly deals with *trait* motivation.

Gamer Mentalities

An empirically derived model of players for all digital game play, grounded in surveys and interviews, is that of nine different gamer mentalities (Kallio et al., 2011), classifying mentalities based on the length, regularity and social context of the game play. The model is divided into three groups of mentalities, each having their own types of play.

Social Mentalities: Gaming with Kids, Gaming with Mates, Gaming for Company
Casual Mentalities: Killing Time, Filling Gaps, Relaxing
Committed Mentalities: Having Fun, Entertainment, Immersion

It is one of the first models to study social and cultural contexts that motivate people to play games and looks at a broad spectrum ranging from 'casual relaxing' to 'committed entertainment'. They draw attention to player 'needs' in creating these categories. Amongst other needs, they say that people are motivated to play because of social needs, need for relaxation and broader need for entertainment. While we see exploration of needs, we still do not see much discussion regarding player emotions.

Given the broad range of variables it looks at: culture, age, style of play addressed with a limited structure, and they do not throw light on the role of emotions in motivation. The typology focuses on perpetual needs, however they do acknowledge the possibility of these needs overlapping with one another. The motivation is somewhat situation based outside of the game, for example, motivation to kill time. This is one of the few models that look at the window outside of the game to derive player motivations. However, we do not find much information on m2m gameplay motivations and motivational changes based on game states.

Engines and Domains of Play

This model focuses on typologizing play experiences as opposed to typologizing players, their motivations and their behaviours. Some individuals and collaborations from the games industry look at player

motivation from this perspective. In this section we discuss one of the more popular models.

In his GDC talk *Five Domains of Play*, Jason VandenBerghe (2012) uses the "Big 5" personality dimensions from personality psychology (L. R. Goldberg, 1992; McCrae & John, 1992) to map personality types onto player preferences. He showcases (via qualitative data) that players like games that match their personality types. As a model example, *Alice* of *Alice in Wonderland* (L. Carroll, 1992) would like *Minecraft* (Mojang, 2011) as she is open to new experiences. This theory opposes the idea of games being a source for escapism. He explains that perhaps players choose games that fulfill unfulfilled needs their personality is naturally drawn towards. This is an important and new angle to player motivation as it focuses on needs that match player personality types (traits of their personality) but remain unfulfilled and says that players use games to fulfill those needs. In summary, players are motivated by their personality traits and gaps in need fulfillment. The model does not address transitions in needs or motivation based on game state change within the player's gameplay experience. This more or less describes why players pick particular games to play but not why do they continue playing a game.

In 2016, Vandenberghe expanded his theory (VandenBerghe, 2016) and proposed that after players pick games based on their traits, Player Need Satisfaction Theory (PENS) (Rigby & Ryan, 2007) explains what keeps them engaged in later phases. That is their basic needs of autonomy, perception of competence and relatedness (described later in the chapter) drive them in the game with the game states. He doesn't provide much proof for this transition and completely relies on PENS (see below) for his extended model. Vandenberghe's findings overlap considerably with Yee's, concluding that players act in accordance with their personality rather than escaping to be a completely different person. This model like Gamer Mentalities (see above) focuses on needs for motivation but also addresses that motivations are intrinsic and change based on the change of needs, perhaps triggered by the game environment. These models by Vandenberghe do not explore motivation from the perspective of emotions but give us some ground for investigation in moment to moment player motivation.

Reflection on Player Behaviour and Motivation Models

Our research question is related to m2m player motivation and the role uncertainty plays in it. We work through some popularly used models to see the status of player motivation with respect to *state* based dialogue and work around needs and emotions. We also hope to find some links with feelings of

uncertainty or other related epistemic emotions around knowledge gathering to start forming an understanding around the role of uncertainty in player motivation.

The above models show a span of player motivation work done in academia and industry. We have omitted models which overlap to a large extent and do not look at motivation from emotions, needs or m2m perspective, for instance: BrainHex (Nacke et al., 2014), Eight Kinds of Fun (Hunicke et al., 2004) exploring what makes a game *fun*, Whang's model (2004), Segmentation of online gamers by motivation (Tseng, 2011), Zachariasson's types (2010), Jacob's player model (Ip & Jacobs, 2005), Canossa's player typology (Drachen et al., 2009). For further reading, player types literature has been collated by Hamari as a meta-synthesis (Tuunanen & Hamari, 2012).

These models give us first insights into tentative links between player's epistemic emotions like that of uncertainty and their motivation to play. We also see some exploration of player 'needs' both at a macro level (Gamer Mentalities) and we start to see some indication of involving psychological models to address that players might be motivated to fulfill moment to moment needs (Engines and Domains of Play). While the above breadth of work shows how important this field is to academics and practitioners, it also presents an opportunity to analyse contributions and gaps in the current literature with respect to our research quests. The discussed models are representative of a few shortcomings. They are by large standalone approaches towards player motivation rather than building on each other. We see reformed typologies by Bartle and Vandenberghe start exploring *state* based motivations. Bartle's typology with the *Implicit/Explicit* axis does not point to a specific motivation (need or emotion) but Vandenbergh points us towards Self Determination Theory (discussed below). In some models we see recognition of players' 'needs' as motivations we do not see any explicit linkages with 'emotions'. We draw tentative relations between Bartle's *Explorer* type and Yee's *Discovery* type with epistemic emotion of knowledge gathering i.e. curiosity and the related feelings of uncertainty and motivation to resolve it. This gives us reason to look closely into relations between epistemic emotions and motivations in the player (discussed in the next chapter). We also observe the repeating role of 'challenge' reported in these models. We tentatively link that with players' needs and epistemic emotion of feelings of competence (as also linked by Vandenberghe) that may influence their motivation to play. Our hope in our future studies regarding m2m player motivation would be to substantiate these links with evidence and illustrate the role of uncertainty and linked epistemic emotions in these motivations.

Additionally, the above theories do not discuss the link between design of game elements and player interaction to explain motivation. They do not illustrate how designers should arrange game elements to elicit the reported behaviour and underlying motivations. Amongst others, here are two fundamental gaps that compel us to complement these shortcomings with insights from other fields.

(1) *Concentration on Traits:* The majority of the existing player motivation literature focuses on the *traits* rather than *states*. We see some movement towards state based dialogue which may inform m2m motivation in the future but only as an addendum with little rigor or detailed explanation. Moreover, traits are largely describing player's behavior and actions rather than why players acted in that manner even if they are divided into motivational types. There is little insight into situational states; preference based models don't explain *why* or *how* that pattern came about and how it influences subsequent behaviour but look at motivation as a perpetual tendency not impacted by the player's interaction with the game.

(2) *Limited transfer of knowledge from psychology:* 'Why do people do what they do' (Deci & Flaste, 1995) is a much discussed question in human psychology. In games, some researchers (Ryan et al., 2006; VandenBerghe, 2016; Yee, 2016) have explored existing motivational theories and personality types. However, they have barely started exploring emotions, cognition and state based human motivational theories with player motivation. In the next section we lay out what has been explored in games from this perspective and what can be further investigated. Based on the role of emotion and needs in human motivation (see first section of the chapter): we suspect that investigations in these directions will be fruitful in terms of finding a role of uncertainty in m2m gameplay; we suspect players would be driven by the 'emotion' of feeling uncertainty and the 'need' to resolve uncertainty.

Lastly, other creative fields have applied psychological theories in their practise (Pailhès & Kuhn, 2019). Based on the models we studied and reported on, current work in player motivation has also not benefited from exploring other creative fields for inspiration regarding motivational principles and techniques they have applied and tested.

Relevant Motivational Theories

In the following section, we will look at psychological motivational theories and principles applied to players and not play(er) typologies that have been

imported from psychology. Here, we discuss only those models where we find more insights on m2m player motivation and needs, epistemic emotions related to uncertainty.

Self-Determination Theory

Self-Determination Theory (Deci & Ryan, 1980, 2010) deals with innate motivations and pertains to people's psychological needs. Like physiological needs (hunger, thirst), psychological needs are something an organism regularly requires to survive and thrive. In a self-determined state, rewards are spontaneous experiences propagated by the self. People experience a motivation that is intrinsic to the activity, when the activity is performed for *its own sake*; not because we are motivated by an outcome that we perceive as separable from the activity (for e.g. status, rewards, approval etc.). An activity is intrinsically motivating when and because it generates experiences that satisfy our basic psychological needs for autonomy, competence, and relatedness. SDT uses these three assumed basic psychological needs (Basic Psychological Needs Theory, BPNT) (Gunnell et al., 2013; Vansteenkiste et al., 2020) to explain how certain activities are intrinsically motivating.

Autonomy	People feel autonomous or self-determined when they act with volition, willingness, and in congruence with one's self. Autonomy is comparable to what other theories call agency and can be afforded by e.g. offering choice.
Competence	The more competent a person perceives themselves to be at something, the more motivated they are towards that activity. Conditions for this to foster need an optimally challenging activity, success and balanced positive feedback on success.
Relatedness	The feeling of connecting and being connected to others, caring for and being cared for by others. It also addresses the feeling of relatedness with the world and self, irrespective of others.

Table 1. Three basic needs according to SDT

By focusing on need satisfaction based on states, SDT acknowledges that motivation depends on needs generated by experiences while doing an activity. This model thus acknowledges how the activity or environment states can change motivations. The SDT model maps with the role of 'challenge' described in player typologies (Yee, 2019a; Caillois 2001) in motivation via the feelings of competence. In doing that SDT explains one reason as to *why* challenge is motivating for players. It also maps with social

needs of relatedness and brings focus to the need to feel autonomous in performing an activity. This links with epistemic emotions surrounding the sense of agency in performing activities and progressing knowledge about the activity. We will discuss sense of agency later in this chapter and how it could link with other epistemic emotions related to uncertainty.

Player Experience of Need Satisfaction (PENS)

PENS applies SDT to games (Rigby & Ryan, 2007). Autonomy, Competence and Relatedness are mapped to players' needs and satisfaction. PENS states that the motives that drive players to play are the same that drive them to act outside of games: good gameplay satisfies basic psychological needs, that's why it's so (intrinsically) motivating.

PENS is not just a model, but also a five factor scale that adds 'immersion' and 'intuitive controls' to game-specific scales for the three basic psychological needs. It measures motivation which has been extensively used for quantitative studies (Peng et al., 2012; Przybylski et al., 2012).

SDT and its derivative, PENS suggest underlying psychological needs of gameplay and thus go beyond player types or behaviour. While PENS tackles parts of SDT, it lacks discussion of its sub-theories and nuances that are unique to SDT for example conflict between extrinsic and intrinsic motivation. SDT mini theories are largely overlooked in games research (Tyack & Mekler, 2020). Furthermore, there is little insight into how to make games or design game elements that make players self determined or how the state of self determination impacts other player experiences and emotions.

Flow

"The best moments in our lives are not the passive, receptive, relaxing times . . . The best moments usually occur if a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile" (Csikszentmihalyi, 1990).

The theory of flow, created by Mihaly Csikszentmihalyi (1990, 2013), aims at identifying shared characteristics of "optimal experience", times when people report to feel best, which they describe as an experience of complete absorption in the present moment that is "autotelic", done and enjoyed for its own sake. Csikszentmihalyi (2014, p. 49) describes eight characteristics of flow: a task that challenges our skills yet remains achievable; having clear goals and immediate feedback; being fully and effortlessly concentrated on

the task; losing track of worries and events outside the task; having clear goals and immediate feedback; feeling a transformation of time (passing faster or slower than normal); losing the sense of reflective self-consciousness; feeling control over the task. As we see it reiterates that agency, competence and feedback amongst other characteristics are important for a motivated state of flow.

"Inducing flow is about the balance between the level of skill and the size of the challenge at hand" (Nakamura & Csikszentmihalyi, 2009). In boredom or apathy, low levels of challenge relative to a person's skills enable attention to drift. Under conditions of excessive challenge, attention starts to shift to shortcomings of oneself that noticeably obstruct any engagement with the challenges posed (Csikszentmihalyi et al., 2014, p. 243). Although supported by some other theories, flow only explains particular conditions in which motivation has chances to flourish. Flow has been widely adopted in games research (Chen, 2007; Cowley et al., 2008). Flow insists that there is a channel of flow that keeps you motivated when skill and challenge are optimally balanced. If skill is high and challenge is low, people get bored, while if the challenge is too demanding for the skill people tend to get anxious or even panic when the disparity is higher. Considerable game development works on balancing difficulty (rational level design, dynamic difficulty adjustment) and even Koster's *Theory of Fun* all directly draw on and point to flow theory (Koster, 2013).

More recent work by Csikszentmihalyi and others show that skill-challenge balance could matter not because of competence, but because it creates high suspense due to the right amount of uncertainty (Abuhamdeh et al., 2015). It throws light on the optimal information gap needed to stay motivated which touches upon optimal levels of decision and outcome uncertainty. This is a valuable insight for our research on the role of uncertainty in motivation. This is one of the first suggestions that uncertainty around one's own competence is motivating for players. In earlier models we have seen the role of challenge and competence in motivation and here we start to find links between uncertainty and competence. Current player experience research largely assumes that play strength has a U-shaped relation to enjoyment mediated by competence: if competitors are significantly stronger than the player, the player will mostly lose, thwarting their sense of competence, which would be unenjoyable. If competitors are significantly weaker, the player will win without exerting much effort, thus feeling little competence, which may be similarly unenjoyable. Recent work suggests that suspense (see Chapter 3) not competence may mediate the relation between difficulty/competitor play strength and enjoyment (Abuhamdeh et al., 2015).

This tells us that players might be motivated by resolving the uncertainty around the results of the game or the opponent along with being motivated to resolve uncertainty about their own performance. The insight about the importance of performance uncertainty lines with Costikyan's analysis of uncertainty (Costikyan, 2013).

Overall *flow* contributes new information regarding challenge, uncertainty and suspense in player experience but misses out on the nuances (like emotions, needs) related to these constructs with respect to video games. For our research it gives us a starting point of the potential role of uncertainty in motivation and its relation with the motivation and epistemic emotion of feeling of competence.

Plans, Goals

In terms of the role of cognition in motivation, Miller, Galanter and Pribram (1960) introduced the study of goals and plans as an aspect of motivation and behaviour into psychology. They posited that people have an ideal state that they want to reach and continually compare with the current state. If there is any incongruity, then they formulate a plan. This happens in a loop until their current state matches the ideal state they are striving for. There has been rich basic empirical support on this theory, but the theory over time has evolved that neither the plan nor the ideal state have to be static. When we analyse this from the perspective of games, we can say a player is constantly comparing their current state with their objectives and are motivated to continue. In case of knowledge gaps (uncertainty) they formulate plans to overcome the gaps and accomplish goals. Based on this we speculate one of the first links of uncertainty in games and goal achievement. Achievement or results (feedback) in itself have been seen as motivating in the above sections and we have already drawn some tentative links between results and uncertainty earlier in this chapter. However, goal theory adds light to the m2m continuous nature of people striving for goals and thus making evolving plans.

Goals, performance, achievements and feedback cycle has been discussed by a number of researchers in light of motivation and player motivation (Bortnik et al., 2011; Kiesel et al., 2015; Staewen et al., 2014; Deci, 2000). High goal difficulty (Locke & Latham, 1990, 2002) increases effort and persistence, leading to enhanced performance. People seek even more difficult goals if feedback shows performance at goal level or higher. However, if the feedback is otherwise, people tend to be dissatisfied and likely to decrease effort or energy. Goal direction follows a similar path. For specific direction, people show increased attention or strategic planning leading to increased direction,

furthering better performance in overcoming challenges. This kind of problem solving feeds into *analytical complexity* and *solver's uncertainty* listed in sources of uncertainty by Costikyan (2013). Overall, good feedback leads to seeking more difficult goals and negative feedback otherwise, also discussed in game design literature (Schreiber, 2009). With respect to our research in m2m player motivation we speculate that (1) players plan as they go to strive for their goals (2) players aim to resolve incongruity or uncertainty in order to reach their goals (3) uncertain feedback on performance might interact with their m2m motivation to overcome such uncertainty surrounding their performance and goal achievements.

Reflection on Psychology Based Models

The literature above looks deeper into motivation and sheds light on player motivation using the lenses of psychology. It does more justice to player motivation by also looking more closely at motivational needs. Applying SDT to games, we understand that players can be engaged if they perceive autonomy, competence and relatedness. A balance of challenge and skill can put them in the motivated state of *flow*, given the goals are clear and the feedback is propelling. Furthermore, the suspense or uncertainty around one's own competence is an important part of the being in the state of *flow*. Sense of agency literature illustrates the relation between player action, game outcome and the ability of the player to predict the outcome and feel that they controlled it. Goal-setting and planning helps players direct effort. All of these models add some insights to *state* based motivation in players and their motivations behind m2m gameplay. Overall, based on the above models, few needs that must play a role in m2m motivation turn out to be: perception of competence (SDT, goals and flow) , perception of autonomy (SDT and sense of agency), relatedness (SDT, flow and sense of agency: comparison and impact of other players' gameplay), feelings of uncertainty (flow) and feelings of suspense (flow), perception of agency (S.D.T. and sense of agency), achievement (goals). We also draw tentative links of these motivating needs with uncertainty that strengthens our notion of the links between uncertainty and motivation, for example: the motivation to resolve uncertainty regarding outcome of the player's actions. We will explore these links more rigorously in future chapters.

Despite these varied inspections in player motivation, the literature still shows some crucial gaps:

(1) *Limited work on designing for motivation*: Although we have gathered information about player motivation, there is barely any discussion on how to elicit these motivating experiences. We see some of this dialogue when it

comes to sense of agency but otherwise it is mostly theoretical and does little work that would help translate these insights into practical applications. The question of how to design game elements for continuous player motivation remains unanswered.

(2) Limited work on m2m player motivation with respect to specific experiences: While these theories give insights on m2m motivation, the inferences we make from it on m2m player motivation are speculative, especially with respect to other player experiences like uncertainty. For example, even though PENS is derived from SDT it measures overall autonomy, competence, relatedness etc. rather than with respect to motivational state changes based on player-game interaction. In similar lines, most of the models described above report and study player experience for an entire game or gaming in general rather than gameplay moments.

Discussion and Conclusion

This chapter shows the busy patchwork of literature on player motivation. It provides us with varied perspectives that themselves don't readily offer solutions towards the role of uncertainty in m2m player motivation. We have been able to sketch tentative links between (1) uncertainty, player behaviour types and the motivation behind them (2) uncertainty and need based motivation models. We have also found some work showcasing the value of m2m motivation transition based on changing game states and subsequently player needs. Other than providing us with insights it also demonstrates gaps in the field: *Firstly, sizable literature on player motivation is concentrated on traits rather than motivational states* which feeds into limited work looking into m2m transitional states of the game or their relationship with specific player experiences. This gap is of special relevance to our focus, that of the scrutiny of a player's *moment-to-moment* journey. As a field, we have some theories around the importance of state based motivation but we have not yet explored what keeps players continuing to play a game from one moment to another. From a methodological point of view, it can't be emphasised enough that there is almost no work observing gameplay at m2m level. We discuss the term m2m gameplay in more detail and how we address this gap in coming chapters. *Secondly*, *there is limited work on designing for motivation,* so we do not know how to design a game for motivating experiences i.e. investigating the link between design of game elements and player motivation. .

The above models discuss needs (e.g. perception of competence), cognition (e.g. goals, plans) and external events (e.g. game world feedback) changes

that propel the players. However they do not provide much insight into player emotions. We make some tentative links with epistemic emotions in our analysis but that is not elaborately offered by the literature. That said, other researchers have discussed emotions in games and in the next chapter we will study their links with motivation and feelings of uncertainty. The lack of emphasis on emotions in main player motivation literature leaves us wondering how players react to specific feelings, for example, that of curiosity, uncertainty, fear etc. Which of these feelings encourage or discourage the player from playing the game? Do these feelings inform each other? We are specifically interested in understanding which emotions relate with the emotions of uncertainty and how do they individually and collectively affect uncertainty. As discussed, uncertainty falls under epistemic emotions surrounding knowledge acquisition but we do not fully know how these epistemic emotions impact player motivation. Are there ways to elicit these emotions in games and if so can they be done in a way that the player is motivated to continue their gameplay? We will explore these questions by working the literature on emotions in games and finding their links with player motivation. Our goal with this investigation to find how the epistemic emotion of uncertainty is discussed with respect to player motivation. Furthermore, we would like to find relations that we can further study and test.

We acknowledge that game designers have looked into motivation (e.g. cognition (Koster, 2013)) and we have not fully covered all of design literature but picked exemplary ones that mapped most with our investigation. We focused on models that shed light into the role of uncertainty in player motivation, m2m motivation and the ones we found related to epistemic emotions.

In the next chapter we continue this investigation by looking closer into emotions as motivation in games as we anticipate to find more information on the epistemic emotions relating to uncertainty and their role in motivation

Chapter 3

Epistemic Emotions and Games

This chapter continues to answer RO1 and explores the role of emotions in player motivation. It investigates emotions beyond pleasure (like uncertainty) and focuses on answering the question of the role of uncertainty in m2m player motivation. It follows RO1 of navigating motivation literature, in this case exploring emotions as motivation, to position uncertainty.

Emotions in games have received increasing attention from developers, players and researchers in the past few years (Bopp et al., 2018; Endress et al., 2016; Mekler et al., 2016). As discussed in psychology (Bradley & Lang, 2007), emotions are tightly linked with motivation, however, so far the examined emotions with respect to motivation are vastly focused on pleasure (Lazzaro, 2004).

Lazzaro (2004) presented an early and influential model of how emotions impact play. She holds that emotions are essential for a player's focus and aid in their decision-making process, performance, learning and enjoyment. She describes four emotions that are key to fun, based on qualitative data. These are: (1) Hard Fun or 'Fiero' which comes from 'in the moment' personal triumph over challenges thrown in the game. Players like the opportunity to strategize and problem solve. (2) Easy Fun relates to curiosity of knowing more about the game world. They feel emotions of awe, wonder and mystery. She also underlines that wonder comes from improbability. Players are amazed by unusual items and their improbability without them breaking out of the realm of possibilities. (3) Serious Fun is where players are feeling internal sensations of relaxation, relief from their thoughts and excitement. (4) People Fun is enjoyment of emotions like amusement, *schadenfreude,* pride coming from social experiences of competition or cooperation in games.

While Lazzaro's model peeks into the *why* behind what people find fun, it doesn't test these theories, so we do not know about the limitations of these observations and if the said connections actually do apply when tested in specific scenarios. She doesn't tell us how these four types interact with each other and keeps the primary focus on what one would call 'positive'

emotional experience. In her study, she finds other kinds of player emotions like disgust and fear that she doesn't deem as important. She is one of the early researchers who connect the role of epistemic emotions with player motivation to experience fun: Easy Fun is equated to curiosity but doesn't delve into other epistemic emotions like uncertainty, arousal, surprise, anticipation etc.

Emotions in games, originally covered in an attempt to dissect fun, have recently been explored beyond pleasure and positive experiences. Until recently, examining uncomfortable or emotionally challenging gameplay emotions has conflicted with the field's focus on positive engagement and fun. This dominant focus on fun and enjoyment has restricted a deeper approach to game design, hence restricting variety in games (Marsh & Costello, 2012). This is especially important as 'negative' emotions can be meaningful and provide their own kind of gratifications (Bartsch, 2012; Birk et al., 2015; Oliver & Bartsch, 2011). For instance, while players report experiencing extreme negative emotions of disgust and desperation during live action role-playing, they eventually report feeling satisfied from the meaning the game provides as they confront these experiences (Montola, 2010). Cole et al. (Cole et al., 2015) illustrate that players like overcoming emotional challenges and feel these emotions in the safe environment of a game that they wouldn't want to in real life (Jansz, 2005). For instance, one wouldn't want to experience the emotion of uncertainty in real life when it comes to important events like plane landing (whether the plane will land safely or not), while in a game world these emotions are more manageable given that they are not impacting one's immediate danger to life.

Researchers in games and interaction have demonstrated the need to consider a wider range of emotional experiences, including these 'negative' emotions (Cole et al., 2015; Endress et al., 2016; Mekler et al., 2016). They found that players appreciate games that evoke different kinds of emotions like fear, sadness or loss and called these experiences gratifying (Bopp et al., 2015; Endress et al., 2016). This has led scholars to distinguish two kinds of emotions with regard to media: (1) *Hedonic* emotions related to sensations of fun or pleasure which has been studied in video games, and, (2) *eudaimonic* emotions dealing with the pursuit of meaning-making, learning and identity development. Researchers like Mary Beth Oliver, Leonard Reinecke and others model 'meaning' and 'growth' as motivational needs (Oliver et al., 2016; Reinecke & Oliver, 2016). These needs explain why people appreciate emotions that may not be derived from 'positive' player experiences. Often positive and negative emotions interplay (Fokkinga & Desmet, 2012) to create an intense emotional experience. A rhythm between positive and

negative emotional experiences can be crucial for impactful game design (Marsh & Costello, 2012, 2013), for example, when a positive feeling comes from overcoming a negative emotion (Mekler et al., 2016). The following two examples show how games elicit non-traditional 'fun' or 'positive' entertainment by defying the rules of positive player experience by applying two diametrically opposite approaches: (1) The game *Max Payne* (R. Entertainment, 2001) puts the player into the shoes of a policeman whose family was grimly murdered. The player goes through internal struggles and psyche change of Max as you take revenge. This fosters, attachment, reflection, contemplation (meaning) and poses emotional challenge for the player. (2) On the other hand, *QWOP* (Foddy, 2008), where the player has to control the limbs of the runner offer barely any emotional complexity in its theme but is famous for the emotions of frustration it causes in players and yet the game is well received and popular amongst players.

In this chapter we are exploring uncertainty as a feeling which falls under the category of epistemic emotions (defined in coming sections). We will investigate its links with player motivation and hope to find information about the role of uncertainty in motivation that we can further study. As a first step we will describe epistemic emotions with some more depth to establish definitions. This is to get informed about how these emotions interact with each other and thus people's motivation. We do this to find insights into potential links within games. Our aim is to find and illustrate links between motivation and uncertainty that we can use to inform our research goals. We believe that understanding epistemic emotions and their role in games would help us understand motivations behind important facets of gaming like learning (information seeking), discovery, exploration, chance, mastery which are more or less disconnected ideas dispersed in the present literature (see previous chapter). Epistemic emotions like curiosity, surprise, uncertainty, feelings of knowing, tip-of-the-tongue feelings, and so forth (Carruthers, 2017; Metcalfe et al., 2017) have fundamental importance for learning (Pekrun & Linnenbrink-Garcia, 2014) and can strongly impact performance (D'Mello et al., 2014; Kang et al., 2009), yet there is currently not much systematic inquiry into them in games.

Epistemic Emotions

Emotions play an important role in our attempts to acquire knowledge (Morton, 2010), do complex learning and cognitive performance (Pekrun & Linnenbrink-Garcia, 2014). In this, a group of emotions called epistemic emotions attempt to address emotions that count as acquiring or having knowledge (Brun et al., 2008, Ozono et al., 2020). The following list of

emotions are regularly grouped under this term i.e. emotions of: curiosity, interest, surprise, feeling of certainty/uncertainty, feeling of knowing, feeling of familiarity, feeling of forgetting, tip of the tongue feeling, feeling of doubt/confidence, feeling of error, feeling of competence, sense of agency over thoughts and feeling of anticipation (Carruthers, 2017; Hookway, 2002; Meylan, 2014; Michaelian and Arango-Muñoz, 2014; Morton, 2010; Pekrun & Linnenbrink-Garcia, 2014).

Amongst these, curiosity has been most extensively discussed. It is seen as one of the main drivers in knowledge acquisition and performance with the potential to motivate enquiries (Morton, 2010). This is in line with Berlyne's strong claim that "human curiosity is a dispositional drive enough to be second desire only to like appetite or sex" (Berlyne, 1954). Some epistemic emotions, not always labelled as such, are discussed in games research, especially in the context of exploration (as seen in Chapter 2 e.g. (Bartle, 1996; Yee, 2006). Curiosity, a key epistemic emotion and important driver of knowledge acquisition and performance doesn't figure strongly in existing player motivation discussion. Amongst other discussions, it features indirectly in Lazarro's Easy Fun (discussed earlier in this chapter), and as components like discovery in Yee's and Leblanc's models. We take a look at epistemic emotions in psychology to get a better understanding of the concept considering there is little game research in this field. Since the list of epistemic emotions is extensive, we focus on the emotions of curiosity and surprise as the key emotions that relate to uncertainty along with the emotion of uncertainty itself. Based upon research in epistemology and closely looking at existing definitions (Hookway, 2002; Meylan, 2014; Michaelian & Arango-Muñoz, 2014; Morton, 2010; Pekrun & Linnenbrink-Garcia, 2014), we club a few epistemic emotions like familiarity, doubt/confidence, certainty/uncertainty and feeling of error under uncertainty as this is how they are described in game literature (Costikyan, 2013).

In the following sections we elaborate on the emotion of curiosity as a key human motivation and see how it is linked to uncertainty. This is where we suspect to find important information on the role of uncertainty in the fundamental human motivation of curiosity. Further to that, we unpack the emotions related to uncertainty and surprise from the lens of player motivation of curiosity as it is seen as the basis of other epistemic emotions (Berlyne, 1978; Schmitt & Lahroodi, 2008). We discuss their definitions, linkage and utility in player motivation. We highlight some findings regarding epistemic emotions in games research where possible.

Curiosity: Key Motivating Emotion

"Imagine what life would be like without the experience of curiosity. There would be no exploration of the self and world, introspection, search for meaning in life, aesthetic appreciation, scientific pursuits, innovation, and, to some degree, personal growth" (Kashdan & Silvia, 2009). As mentioned in Chapter 1, psychologists have extensively studied the fundamental role of curiosity in motivation, seen as one of the main drivers second only to appetite or sex (Greenberger et al., 1967). Curiosity is a complex emotion captured by several psychologists, philosophers, creatives and experts. It has been studied for over a century, which is possibly why we see such diverse definitions and models that try to fully explain and capture it (Kashdan & Roberts, 2004; Silvia, 2006). Amongst the contradictions between many existing and emerging models of curiosity, they all acknowledge the importance of curiosity in many aspects of human life like survival, learning and enjoyment. We believe this role of curiosity must transfer to games as pointed out by researchers and designers (Costikyan, 2013; Sutton-Smith, 2009). That said, existing work fails to empirically establish the role of curiosity in *state* or *trait* based player motivation models. This leaves us with speculations that are not tested in terms of establishing the link between curiosity and player's motivation to engage with the game. Current literature also does not fully explain how to design game elements to elicit the feeling of curiosity backed by tested applications.

Traditionally and popularly, curiosity is seen as an innate desire and approach-oriented motivational state (F. Arnold, 1910; Dewey, 1913) associated with exploration (Kashdan & Silvia, 2009) and learning (Malone, 1981). Curiosity makes people inquire (Inan, 2013), interact with complex/interesting objects and images (Reeve & Nix, 1997; Silvia, 2005), read deeply (Schiefele, 1999), and persist on challenging tasks (Sansone & Smith, 2000). It drives learning, exploration and immersion in interesting, challenging and uncertain situations leading to the building of knowledge and competence (Kashdan & Silvia, 2009). Curiosity is seen as an intentional phenomenon directed at objects (Meylan, 2014). For instance, an individual is not unspecifically curious (like they can be happy unspecifically, but are curious to know specific information like whether their mother appreciated her night at the cinema or not). To acquire information successfully people need to be curious at the right moments and to the right extent (Morton, 2010). Finding novel, intricate, and unexpected things activates a positive reward system (Berlyne, 1971) which motivates further novelty seeking and exploration (Kashdan & Silvia, 2009). Evolutionary pressure has made such

searching for new information intrinsically rewarding (Gottlieb et al., 2013; Marvin & Shohamy, 2016). Kashdan and Silvia describe the role of curiosity in knowledge/skill expansion as something that makes people focus on the novelty and challenge that each moment has to offer. It is rather profound that they say, "When curious, we are fully aware and receptive to whatever exists and might happen in the present moment" (Kashdan & Silvia, 2009). As discussed in the last chapter with reference to motivational models many of these elements: discovery, exploration, challenge could be connected with uncertainty and people's motivation to solve it. The motivation to solve that uncertainty based on the above literature might then be the motivation of curiosity.

Even though curiosity is fundamental it has barely appeared in player experience and player motivation models. Player motivation models that include discovery, exploration, information seeking, openness, novelty and aspects of challenge (see Chapter 2) should logically intersect with the construct of curiosity, yet very little is explicitly stated and it is us who are tentatively making these links. Only a few models of player motivation recognise curiosity: Lazzaro classifies it as 'Easy Fun' (Lazzaro, 2004), and Klimmt showcases curiosity as a part of a conceptual model for player enjoyment (Klimmt, 2006, 2003). Other researchers hint that the use of foreshadowing and back-story can be employed to create curiosity in narrative games (Bae & Young, 2008; Dickey, 2005; Park et al., 2010). Costikyan's work regarding the role of uncertainty in games talks about involvement of curiosity without much detailed exploration (Costikyan, 2013). In all of this work what we miss is: empirical support to claims that substantiate the theory through systemised testing, exploration of curiosity from the perspective of application in games and utilisation of diverse curiosity models found in psychology literature.

Psychological models of curiosity are in agreement that epistemic curiosity is the desire for new knowledge; usually associating states of curiosity with enjoyment (Silvia, 2006). However, another school of thought poses curiosity as aversive (Loewenstein, 1994). Unifying these two theories, Jordan Litman develops a two-type model of curiosity (Litman, 2008, 2005):
(1) Curiosity aimed at stimulating pleasurable feelings where people seek information out of interest (I-type). It is related to discovery, exploration, enjoyment and openness to novelty (Y. B. Kim & Lee, 2017; Litman & Jimerson, 2004; Mussel, 2010).
(2) Curiosity aimed at relieving the feeling of knowledge deprivation (D-type), where people seek information out of frustration of not knowing (Litman, 2005) or for resolving uncertainty (Y. B. Kim & Lee, 2017) and

eliminating undesirable states of ignorance (Litman & Jimerson, 2004). Fowler (1965) calls it an aversive experience that motivates its own reduction. D-type curiosity is related to problem solving, uncertainty aversion, tension, anger towards information gaps (Y. B. Kim & Lee, 2017; J. A. Litman & Jimerson, 2004; Loewenstein, 1994). An example would be the anxiety of scientists driven by pursuit of their research questions (Kashdan & Steger, 2007). This type of curiosity is one of the links we have been hunting for between human motivation and uncertainty.

While I-type deals with the exploration of new knowledge, D-type fosters exploration of existing knowledge (Litman et al., 2005; Schoenau-Fog, 2011). Research shows that people who have high I-type curiosity also have high D-type curiosity and the two dimensions are correlated with respect to exploration of new knowledge leading to exploitation of competency (Litman, 2008; Litman et al., 2010;Litman & Mussel, 2013). In creative problem solving, D-type allows information seeking and I-type helps generate new ideas (Hardy et al., 2017). This strengthens the analysis we made in the previous chapter: that players 'seek' new information through exploration but then they are motivated by resolving the uncertainty gaps to get to the information.

Within games, To and colleagues (2016) suggest that curiosity could be a precursor of *flow*, steering people to actively create an information gap experienced at the optimal level of challenge and uncertainty (Garris et al., 2002; To et al., 2016). The uncertainty and anticipation around a game outcome is a fundamental part of what defines a game. This positions the player's curiosity regarding what would happen next at the heart of play (Juul, 2010b). To et al. (2016) map Costikyan's work on uncertainty in games (Costikyan, 2013) with curiosity and suggest game designers can create curiosity by staging moments of uncertainty.

Games cannot change a player's *trait* curiosity, but can create situations via mechanics and other game elements that affect their *state* curiosity (To et al., 2016). Suggestions include (1) using visuals and sounds to create gaps in perceptual information about sensory experiences such as touch, sight, and sound (Berlyne, 1954) like in any game where audio is used to guide attention, or (2) creating curiosity with an object that can be explored by manipulating it. For example, in games like *The Room* (Fireproof Games, 2012), *Where's My Water* (Feep, 2011) and other puzzle games, manipulating the objects gives more information about the game space. All of this is essentially creating an information gap or uncertainty that players are curious to resolve.

This section tells us that the human motivation of curiosity and emotions of uncertainty are indeed linked as people channel curiosity to resolve uncertainty. While To et. al. offer some ideas of how to elicit curiosity in games, they don't show that the ideas they offer have been tried and proved. Neither does it tell us if that kind of curiosity is driven through uncertainty or need to resolve uncertainty or not. Our aim is to strengthen these links through further research. In the following section, therefore, we study this link of uncertainty as a salient state for the motivation of curiosity.

Uncertainty: Antecedent to Curiosity

In the following passages, uncertainty is discussed as a major antecedent to curiosity. We also discuss the features of uncertainty that particularly evoke curiosity and the research done in games that explores this linkage. The most direct situational factors that trigger curiosity are uncertainty or unpredictability and incongruity (Berlyne, 1962; Boykin & Harackiewicz, 1981). Curiosity triggered by uncertainty is due to a gap in desired knowledge and the need to resolve it (Kagan, 1972). Curiosity regarding an unknown outcome coincides with a desire to know whether the guess is correct. Exposure to an unexpected outcome (incongruity) leads to uncertainty motivation to find an explanation (Shin & Kim, 2019). We suspect that within games, incongruity and uncertainty can be seen to go hand in hand: players feel uncertain about novel elements which they explore, they guess the outcome but if that is unexpected they go back to exploration. From the above, we theorise that uncertainty triggers curiosity for outcome in game scenarios.

Shin and Kim (2019, pp. 853–874) argue that "humans have evolved to be deeply curious to adapt to a world of uncertainty." Wilson et. al. explain this by posing uncertainty as an anxious state that the human mind would like to eradicate (Wilson et al., 2005). Curiosity functions primarily as a coping mechanism for such uncertainty (Shin & Kim, 2019). For example, our ancestors would resolve uncertainty by interacting with and exploring novel stimuli (like strange animals) (James & BF, 1918; Russell, 1973) to lower potential danger and increase their chances of survival (Shin & Kim, 2019). That probably offers a one to one mapping to player behaviour in survival games. Individuals are motivated to eliminate uncertainty regarding information gaps when the benefit of resolving it is perceived to be greater than the cost (Golman et al., 2015, S. I. Kim, 2013). Loewenstein compares curiosity with cognitive appetite (Loewenstein, 1994) where it is a desire to reduce the psychological discomfort of uncertainty (Shin & Kim, 2019).

Therefore we suspect, within a game if uncertainty is balanced with the cost of effort and reward at the end of it, players will be curious (motivated) to resolve this uncertainty.

To et. al. (2016) argue that game designers could use uncertainty to motivate, manipulate, and accommodate players' curiosity levels. They use Loewenstein's model of curiosity, which describes curiosity as a person's preference for resolving uncertainty and filling "information gaps" between the known and unknown. They describe curiosity as a 'preference for uncertainty', where uncertainty is the result of this information gap. The ability to tolerate information gaps predicts whether a person responds to such situations with curiosity rather than helplessness, frustration, or anger (Loewenstein, 1994); (for empirical support, see (Jirout & Klahr, 2011; Litman & Jimerson, 2004)). This is in line with games research saying that too much uncertainty causes frustration while too little doesn't raise curiosity to solve it (Costikyan, 2013). Players presumably have differing tolerance levels for uncertainty. Situational factors can affect that tolerance and a players' confidence in their ability to close a knowledge gap (To et al., 2016) relating to the needs of feeling competent. To et. al. provide a theory about uncertainty in games and curiosity based on psychology literature, however, they do not exhibit any of these links through application in games or studies. Studies show curiosity increases with determinants of uncertainty and degree of conflict such as number of alternative responses (Berlyne, 1962). This throws light on the role of choices (in games and otherwise) in creating uncertainty and thus curiosity. That is, when people need to choose between options, the conflict increases creating uncertainty and curiosity. This is an important link to discuss uncertainty during decision making and the role of that in making players curious towards the outcome.

Finally, People invest effort in attaining uncertain information in response to prediction error and the violation of expectations (Baranes et al., 2015; D. E. Berlyne, 1954; Loewenstein, 1994; van Lieshout et al., 2018) as they are curious about the occurrence. The violation of expectations leads to feelings of surprise (Lorini & Castelfranchi, 2007; Reisenzein, 2000). Following this we can say that players could be motivated to resolve uncertainty when they face surprise: 'what just happened?', 'how did that happen?'. This relation is further discussed in the next section.

Overall, the linkage between uncertainty and motivation (curiosity) is theoretically explored by To et. al. (2016) in games but not tested beyond the mapping from psychology. Other than that, we do not find much linkage between uncertainty and the motivation of curiosity in games literature. This

section thus explores this angle in psychological literature and finds that people are motivated (curious) to resolve uncertainty especially when the cost of resolution is not too high compared to the anticipated reward. People are curious to find the results. We also draw insights that people thus players might tackle uncertainty by further interacting with and exploring novel environmental content. These linkages are further substantiated with respect to games in Chapter 4.

Surprise: A Reason to Resolve Uncertainty

Surprise is an emotion that can be evoked by curiosity built up or out of the blue as a reaction to unexpected events. However, in the following passages we only discuss surprise that is motivating and is linked with curiosity and uncertainty. Further to that, we discuss the features that evoke surprise.

Curiosity regarding the outcome coincides with a desire to know whether one's guess is correct or not (Shin & Kim, 2019) i.e. wanting to resolve uncertainty related to the outcome. Exposure to an unexpected outcome subsequently leads people to wonder about the accuracy of the ensuing causal inferences. Curiosity resulting from such incongruity is marked by acute feelings of surprise which may be followed by confusion (Brod et al., 2018; D'Mello et al., 2014; Kamin, 1967). Surprise basically heightens interest in finding out more about something that defies prior learning, which makes it a useful tool in game design. When players encounter an unexpected outcome (uncertainty towards outcome met with more resolvable uncertainty), chances are they want to solve this incongruity and stay engaged in the game.

Overall, the experience of surprise is a reaction to realising a mismatch between our expectations and our understanding of the working of the world (Lorini & Castelfranchi, 2007; Reisenzein, 2000). The surprise can be pleasant, unpleasant, or neutral depending on the expectations themselves (Ortony & Turner, 1990, Meylan, 2014). Rex-Stout, an American detective fiction writer aptly describes the range of surprises and the role of individual perspective: "[A] pessimist gets nothing but pleasant surprises, an optimist nothing but unpleasant (R. Stout, 2010)." He brings our attention to the unpleasant end of the spectrum, for example, the sudden onset of a pandemic which still propels people to find solutions and tackle the surprise. Surprise is central to sensory processing, adaptation, learning, and attention (Itti & Baldi, 2006): our ability to rapidly attend to, identify, and learn from such surprising events, make immediate decisions and plan for the future plays a key role in survival (Ranganath & Rainer, 2003, Vidler & Levine, 1981).

Mismatch with expectations makes people engage in making and testing alternative predictions, investing effort in searching for causal relations (Berlyne & Frommer, 1966; Maheswaran & Chaiken, 1991) and adapting their knowledge to the changes found (Brod et al., 2018; Greenberger et al., 1967; Itti & Baldi, 2006). Following this logic, we suspect that within games, when players' uncertainty regarding outcome is met with surprise, they are motivated to engage with the content to make and test alternative predictions.

Surprise all by itself is not thoroughly studied in games research. Given its role in learning, we suggest that deepening the understanding of surprise will inform the use of causal relations in games. In fact, as we will see in the next chapter, stage magic deliberately works with establishing and breaking audience expectations about causal relations to stoke engaging surprise and curiosity. That said, it is important to see that game design can use the full spectrum of surprise, not limited to fun and pleasant sensation. Even an unpleasant or neutral form accelerates learning and decision making, which are building blocks of games and player experience.

Factors that Evoke Epistemic Emotions

Lastly, we point out some recurring features that induce the epistemic emotions stated above. We do so as our research is not only about understanding the role of uncertainty in player motivation but also how can such uncertainty be designed for in games. By illustrating the features that induce the stated epistemic emotions in general we hope to draw ideas that we can apply to our research question specific to games. Amongst others the ones discussed the most in psychology and games are: novelty, challenge and suspense.

The importance of novelty in epistemic emotions is discussed above in: I-type curiosity and surprise. People seek out novel ideas, engaging in actions out of intrinsic interest and thrive on novelty and challenge (Kashdan & Silvia, 2009). Lomas et al. (2017) argue that novelty plays an important role in player motivation. Furthermore, when people are confronted with challenge in addition to novelty, the primary responses tend to be related to curiosity and anxiety (Kashdan & Silvia, 2009). Theories of intrinsic motivation place novelty among primary factors that arouse interest, motivate exploratory behavior, and drive learning (Barto et al., 2013).

Game researchers have found games to be most enjoyable when they are ‘close games’ (not won or lost by a huge margin). They attribute the

enjoyment to dramatic suspense (uncertainty of outcome) (Abuhamdeh et al., 2015; Abuhamdeh & Csikszentmihalyi, 2012; Ely et al., 2015). Lomas et al. draw the relation between suspense and player motivation to be optimal when suspense is moderate (Lomas et al., 2017). Suspense need not be about the entire game's outcome; it can be at a task level (Khajah et al., 2016); or perhaps about their own narrative arc as they play the game: 'narrative anticipation' source of uncertainty by Costikyan (2013).

In various forms of storytelling (text, plays, magic, games etc.), suspense is evoked by delaying the story's (known or open for prediction) outcome (for e.g. (Suits, 1978)) creating an uncertainty about when the outcome will be presented. Curiosity is evoked by presenting the outcome but not the events that led to it, and surprise is evoked by an unexpected event (Hoeken & van Vliet, 2000). Alfred Hitchcock poses suspense and the emotion of surprise as the main tools for storytelling. However, he celebrates suspense more: "Suspense, which is the most powerful means of holding to the viewer's attention" (Truffaut et al., 1984, p. 50). He famously distinguishes it from feelings of just surprise in his example where he says that surprise occurs when a bomb blasts from nowhere whereas suspense is when the audience knows that a bomb is ticking and participates in the drama of its explosion (Truffaut et al., 1984, p. 73). The role of feelings of uncertainty and feelings of anticipation evoked by suspense is the key motivator of engagement towards outcome. Suspense can be invoked even when the readers/players know how the game's narrative or their player journey would end (Hoeken & van Vliet, 2000). Even if the outcome is certain, suspense can arise as people express uncertainty as they progress towards the outcome (Gerrig, 1989).

We continue to discuss uncertainty, suspense, surprise and curiosity in the context of player motivation in the coming chapters.

Discussion and Conclusion

This chapter emphasises the role of emotions beyond 'fun' in player motivation. It attempts to provide a broader understanding of epistemic emotions beyond the literature discussed in games. We do so to find what we know about the emotion of uncertainty and its relation with the motivating emotion of curiosity. The links established in this chapter motivate us to look deeper into this relation and strengthen it through empirical studies (illustrated in coming chapters) that support the connections made in the context of games. One of the key learnings is the essential position curiosity holds in human life and its fundamental role in both *state* and *trait* based motivation models. We learn that curiosity can be pleasurable and elicited

out of interest but on the other hand it can be aversive, evoked out of information deprivation or uncertainty. While such nuances are widely studied and debated upon in human motivation, they are very superficially explored by few game researchers (e.g. To et. al. (2016)) when it comes to games.

We find that curiosity is connected to chance (uncertainty towards outcome), challenge, competence, discovery, exploration, performance, and information-seeking, which are constructs otherwise scattered across player motivation literature. We also evidence the close link of uncertainty and curiosity and how uncertainty is arguably a key precursor: curiosity is evoked by the need to resolve (resolvable) uncertainty. Additionally, we show the link between curiosity towards outcome and the emotion of surprise: the violation of expectations enables the need to resolve uncertainty furthering the need for learning and further curiosity (information seeking). In addition, we show how these emotions often flow into each other in the process of information gathering. We do so to establish that uncertainty and related epistemic emotions can indeed be motivating and more specifically the primary motivation that players might feel when they encounter uncertainty is curiosity. This leads us to hypothesize that the role of uncertainty in player motivation is to create the motivation of curiosity- either directly or through the emotion of surprise.

We find that game research lacks attention towards the role of epistemic emotions, especially, when it comes to eliciting them in games. In games research, we chiefly observe non-empirical theorising about possible links between epistemic emotions (for e.g. (Suits, 1978; Sutton-Smith, 2009)) which does not say if particular methods of eliciting epistemic emotions actually work and if so with respect to what kind of player motivation. This theory generation is most systematically done by Alexandra To and colleagues (To et al., 2016). The most developed empirical work questions whether game difficulty is motivating because it supports competence. Instead, it proposes that it is motivating because balanced difficulty increases novel challenges and close (uncertain) outcomes, both of which evoke curiosity and suspense (Abuhamdeh et al., 2015; Lomas et al., 2017).

General psychology has sliced and diced uncertainty and when it becomes motivating in various ways, which at certain junctions intersects with Costikyan's theories, but nobody has looked at that potential mapping systematically or tested it empirically, thus we do not fully know the limitations and application of his observations. We attempt to fill this gap by investigating uncertainty and how it can be manipulated by designers.

Chapter 4

The Role of Uncertainty in 'Moment to Moment' Player Motivation[2]

Uncertainty has long been recognized as a key ingredient of engaging gameplay (Caillois, 2001; Costikyan, 2013; Johnson, 2018; Power et al., 2019). In his early typology of play, Caillois (2001) famously describes the relation between *alea*, chance-based play, and *agon*, skill-based strife, observing that either would lose its appeal if it lacked the fitting kind and degree of uncertainty, such as an instance of *agon* where the outcome is determined by luck or is certain from the outset.

A great number of game designers and scholars have since reiterated the importance of uncertainty for a good player experience, and diversely tried to identify different kinds or sources thereof (DeKoven, 2002; Golman et al., 2015; Juul, 2011; LeBlanc, 2006; T. W. Malone, 1982; Salen et al., 2004). Terminologies and theories vary. Thomas Malaby (2007) for instance draws on sociological and anthropological thought on *contingency* to argue that games are engaging because their 'contrived contingency' allows us to engage with the basic indeterminacy of human existence. Mark Johnson (Johnson, 2018) meanwhile deploys Deleuze to tease apart different kinds of *unpredictability* in games of chance. Both authors concur that some perceived lack of certain knowledge about what is the case, what to do, or what will happen at a future moment is core to the motivational pull of gameplay. Drawing on many of these sources and his own practical experience, game designer Costikyan developed an influential categorization of eleven sources of *Uncertainty in Games* (Costikyan, 2013). He includes e.g. stochastic randomness as in a *Roulette* game, hidden information (like the hidden cards of an opponent in *Poker* or *Hearthstone* (Blizzard Entertainment, 2014)), or player unpredictability - for instance, in *Mario Kart* (Nintendo EAD, 2014) players are uncertain if they will be able to push the acceleration with optimum timing to get the best start. Building on this descriptive categorization of uncertainty as a *game feature*, Power and colleagues (2019)

[2] The study described in this chapter is also a published work (Kumari, Deterding, & Freeman, 2019).

have attempted to measure and differentiate uncertainty as a player experience. Their *Player Uncertainty in Games* Scale (PUGS) distinguishes five factors: uncertainty in decision-making, uncertainty in taking action, uncertainty in problem-solving, exploration behaviour to reduce uncertainty, and external uncertainty, capturing random(ized) outcomes.

Valuable as the typologies of Costikyan or Power (and the work informing them) are, they leave the basic question unanswered *when* and *why* uncertainty is engaging: What psychological mechanisms explain when and how different kinds of uncertainty motivate? Costikyan variously alludes to psychological constructs in footnotes, but as a designer, he chiefly teases apart structural game features, taking their motivational pull as a given. Power et al. similarly are more interested in reconstructing uncertainty as a definitional "foundational experience" *characteristic for play* than in understanding how it may *motivate* play (Power et al., 2019). Starting with Thomas Malone (1982), researchers have suggested and tested links between uncertainty and curiosity and suspense in games (Abuhamdeh et al., 2015; Howard-Jones & Demetriou, 2008; Lomas et al., 2017; To et al., 2016), but such work has remained sparse and disconnected.

What's more, current constructs in game uncertainty research are not grounded in naturalistic observation (players observed as they are playing in their natural setting). No matter if Caillois, Johnson, Costikyan, Power, or others: all develop theoretical models drawing on personal experience as game designers and prior scholarship. Factor analysis (as used by Power and colleagues) may reveal whether there is a structure among such theory-derived items that reflects a structure in people's self-reported experience, but not whether these items capture all, or even all important aspects of the phenomenon in question. One likely blind spot of existing research in this respect is that it chiefly relies on 'summative post-hoc' memories of a gameplay session rather than probing instances of gameplay via video recalls, taking observational notes during talk-aloud gameplay sessions or asking players to do diary entries right after each of their play sessions. This brings with it the well-known issues of memory biases and post-hoc rationalization - the "memory experience gap" (Miron-Shatz et al., 2009): remembered experience is not lived experience, and yet it is lived experience that determines whether a player continues to play a game at any given moment (or stops), and forms the memories that inform their decision to pick it up again. In contrast to summative gameplay stands what game designers call *moment-to-moment (m2m) gameplay* (Sivak, 2012; Swink, 2007b, 2009). M2m gameplay describes the player's experience of the game

from one moment to the next. Uncertainty has yet not been investigated at this nuanced level of granularity.

As seen above, uncertainty in games is still a relatively new topic where player reports and existing literature suggest that it plays a key role in making the gaming experience richer. Even if so, there is little to no empirical investigation how uncertainty makes player experience richer, or motivates players to progress in a game, or what additional impacts it may have on other player experience constructs (for example: player immersion). In the following study we attempt to understand *when* exactly do players experience uncertainty and furthermore *why* is it important to their gameplay experience addressing the multifaceted nature of uncertainty.

As discussed above, existing work provides descriptive typologies of structural game sources of uncertainty and dimensions of experienced player uncertainty, but neither are these typologies grounded in (or validated against) naturalistic observation, especially of lived m2m gameplay experience, nor do they provide explanatory models when and how uncertainty engages. We conduct a qualitative study combining biographical interviews, diary entries, observations with video-aided recall of gameplay combining post-hoc memories with ways to capture in-the-moment reactions and revisiting the gameplay through the video and probing them to remember particular moments of gameplay. The reactions of the players are more than summative or generalised about their experience of a particular game over an extended period of time but also capture details during the live gameplay experience or revisit the lived gameplay experience through video-recalls. It constructs a grounded theory of how uncertainty engages players in m2m gameplay and establishes links with existing motivational constructs.

Moment to Moment (m2m) Gameplay

As discussed in Chapter 2, m2m gameplay is one of the gaps in existing player motivation literature and thus barely defined. We take a moment to unpack this term before further delving into uncertainty from this perspective. It is a commonly used term by game designers and players (EuropeOG, 2015; Sivak, 2012; Swink, 2007a, 2009) to explain the interaction at concurrent snapshots in time. M2m gameplay describes experience on the level of second-to-second input-output pairings around the game's core loop (Sicart, 2015), as opposed to the longer arcs and loops of game goals and player strategies (Parijat, 2017; Saunders & Novak, 2012; Suckley, 2017; Sundell & Profile, 2016). This distinction echoes game scholars like Salen and Zimmerman (2004), who

distinguish between a "micro" and "macro" level of player uncertainty, or Klimmt's (2006, 2008) distinction of three analytic levels of entertainment experiences in gameplay, with "input-output loop" as the lowest level. Importantly for our context, game designers hold that smooth, engaging m2m gameplay makes or breaks player engagement and retention (Chmielarz, 2012; Romero, 2011).

The term is interchangeably used with second-to-second interaction, gameplay or experience (Parijat, 2017; Saunders & Novak, 2012; Suckley, 2017; Sundell & Profile, 2016). There is no clear consensus on what the terms exactly mean however, there is a very clear importance placed on m2m design of the game (Chmielarz, 2012; Parijat, 2017; Romero, 2011). It concentrates on the core mechanic that the game revolves around and the actions the player has to do repeatedly in the tightest loop of the game (Baumgart, 2011; Romero, 2011). Research so far has little to no insight on what happens during m2m gameplay with respect to mechanics or game elements to motivate a player into continuation or demotivate a player to disengagement. We choose this lens considering game designers can't really control the state players enter the game in. However, they can possibly arrange the game elements (goals/objectives, reward/feedback etc.) in a way that motivates players to continue playing on a m2m basis. Games being complex systems, we suspect a number of such game elements to be at play in fostering m2m motivation.

These arguments make it relevant to capture and understand gameplay experience and underlying affordances at the m2m level. For the purposes of this thesis, we will use *moment-to-moment (m2m) gameplay* to refer to game interactions and player experiences that take place on the time scale of seconds in line with the game's action-reaction loop; and *m2m motivation* describing players' motives for continuing gameplay interaction from one action to the next. More precisely, m2m is defined with respect to the core repeating action-reaction loop of the game propelled by the communication between the game and the player: the game presents an opportunity for the player to act, the player performs an action in the game, the game immediately responds with the next state to which the player responds and the m2m loop continues. For example, in a game like *Super Hexagon* (Cavanagh, 2012) a m2m gameplay would be the game presenting a new pattern and the player immediately responding with a movement action to avoid collision and this loop continues unless the game ends. Any state change in the game (including player attributes) propelled by the game or the player or both would contribute to the m2m gameplay. We suggest that m2m gameplay adds up to the overall gameplay experience and is not separate

from it. We define m2m motivation as the motivation player feels in every such loop to act in the game. M2m uncertainty is defined as the uncertainty player feels during this action-reaction loop and impacts their m2m gameplay and m2m motivation. M2m and overarching uncertainty are not independent of each other, for example a non-m2m level uncertainty would be uncertainty that players feel about overarching features of the game that do not impact their m2m gameplay or m2m motivation whereas a m2m uncertainty impacts the immediate m2m gameplay of the player. From a methodological perspective observing and recording m2m gameplay as the gameplay occurs would be one way to record m2m level player experiences and motivations.

Study: Exploring M2m Motivating Uncertainty using Grounded Theory Investigation

This study addresses the second Research Objective.

RO2: '*To explore when and why uncertainty becomes motivating in m2m gameplay.* '

Uncertainty is widely acknowledged as an engaging characteristic of games. Practice and research have proposed various types and factors of game uncertainty, yet there is little work explaining *when* and *why* different kinds of uncertainty motivate, especially with respect to 'micro-level', m2m gameplay. We therefore conducted a qualitative study combining biographical interviews with video-aided recall of gameplay to construct a grounded theory of how uncertainty engages players in moment-to-moment gameplay.

Method

The work presented here is part of a larger exploratory grounded theory study of m2m motivation in so-called 'pick-n-play games'. Based on prior literature, we operationalized 'pick-n-play' (our sample focus) as "games one can learn and conclude a satisfying play session in 10 minutes" (Cheng, 2011; Juul, 2010a; Kultima & Karvinen, 2016; Rohrl et al., 2008; Trefry, 2010). To avoid priming of e.g. distracting stereotypes around terms, we were careful to never use labels like "pick-n-play" or "casual" with participants. We only spoke of "games which are easy to learn and access". We specially focused on these games for two reasons: (1) to counterbalance player motivation research, which preferentially studies console/PC AAA games (Juho Hamari & Tuunanen, 2014; VandenBerghe, 2016); (2) methodologically, we sought contained games i.e. games with limited scope of player interactions and a simple game architecture revolving around one main player interaction as

that would allow us to easily observe repeat m2m player experience around the game's core loop.

Since our study was focused on m2m player motivation, our data revealed a range of game features like rewards, feedback etc. and connected emotions and motives like the feeling of progression, need for routine, feeling of accomplishment. However, uncertainty quickly emerged as a central and highly differentiated category, warranting separate treatment. After developing a general grounded theory of m2m motivation in 'pick-n-play' games, we therefore conducted a focused analysis of all data passages coded for uncertainty, which we report in this write-up.

Participants and Material

Due to the focus of the larger study, we recruited active players of games on mobile devices. We recruited and screened prospective participants through a questionnaire distributed via social media, in which they indicated their age, gender, and the games they regularly play. We purposely sampled participants from this pool who reported currently playing games what qualified as pick-n-play by our definition and offered a range of gender, age, and games played (see Table 2). In total, we collected data from 13 players, 7 women and 6 men, aged 18 to 54. All participants spoke English and had prior familiarity with games. We stopped data collection at 13 participants when we reached theoretical saturation, which aligns with prior work indicating that saturation occurs around 12 participants (Guest et al., 2006).

ID	Gender	Age	Data Type	Game	Genre
P01	M	35 - 44	Interview, Diary Entry, Video-aided Recall Interview	*Golf Clash (Playdemic, 2017)*	Sports
				Clash Royale (Supercell, 2016)	Strategy
P02	F	18 - 24	Interview	*Cooking Fever (Nordcurrent, 2014)*	Simulation
				Temple Run (I. Studios, 2011)	Platformer/ Runner
P03	M	25 - 34	Video-aided Recall Interview	*Fruit Ninja* (H. Studios, 2010)	Puzzle
				Jetpack Joyride (H. Studios, 2011)	Platformer/ Runner
P04	M	25 - 34	Video-aided Recall Interview	*PinOut (Mediocre, 2016)*	Arcade Simulation
P05	M	18 - 24	Video-aided Recall Interview	*Monument Valley (Ustwo Games, 2014)*	Puzzle
P06	F	25 - 34	Interview	*Two Dots (Playdots, 2014)*	Puzzle
P07	M	25 - 34	Video-aided Recall Interview	*Exploding Kittens (Kittens, 2015)*	Card Game
				Blaze Hopper (S. H. Studio, 2018)	Platformer/ Runner
P08	F	18 - 24	Video-aided Recall Interview	*Tap tap tap (Bonte, 2015)*	Puzzle
P09	M	25 - 34	Video-aided Recall Interview	*Tap Tycoon (Corp., 2015)*	Simulation
P10	F	25 - 34	Video-aided Recall Interview	*Merge Plane (M. Games, 2018)*	Simulation
P11	F	25 - 34	Video-aided Recall Interview	*Super Hexagon (Cavanagh, 2012)*	Puzzle
P12	F	18 - 24	Interview	*Picross (Company, 2017)*	
				Logic Puzzles (Boyle, 2019)	Puzzle
P13	F	45 - 54	Interview, Diary Entry	*Candy Crush (King, 2012)*	Puzzle
				Candy Crush Soda (King, 2014)	Puzzle
				Farm Heroes (King, 2013)	Puzzle

Table 2. Participant demographics and the games they report on

Data Collection and Analysis

We did not enter the study with any hypothesis but to understand m2m motivation and generate a theory. To remain open to constructs and relations not already captured in prior theory, we intentionally chose an open, theory-generating approach that allowed researcher's subjectivity of gathering sense in the data and allowed for iteration in the methodology.

Specifically, we followed Constructivist Grounded Theory as developed by Charmaz (2014). We looped data collection, transcription, coding/analysis, and memoing/theorizing to initially reconstruct players' own in-vivo labels and emic categorizations, to then develop our own higher-level constructs following Charmaz' (Charmaz, 2014) sequence of initial, focused, axial, and theoretical coding. We started collecting data as combined episodic interviews and week-long play diaries. Players were asked to continue playing their reported game (the game they reported that were playing during screening) in their natural environment (e.g. while commuting, during work breaks etc.) as they would for a week. During the week, we asked them to record their session experience in a diary after play. After the week, we interviewed them on their experience of the game and used diary entries to probe into their player experiences. We quickly discovered that diary data remained relatively 'thin' i.e. it echoed similar insights as the interviews and did not make the data much richer. The episodic interviews revealed a diversity of uncertainty experiences, but we wanted additional granular capture of linkages between gameplay experience and game features. We therefore enriched the interview with video-aided recall i.e. we asked players to play the game in front of the researcher while thinking aloud (choosing the most natural habitat possible: online or in-person), screen-record the play sessions and then participate in the interview, which proved additionally insightful. In total, we collected

- 5 semi-structured episodic interviews, each about 45 minutes in length; three in person, two over video-call.
- 2 diaries of play experiences over one week, using some of the episodic interview questions as a daily prompt;
- 9 video-aided recall semi-structured episodic interviews, again of about 45 minutes in length; six in person, three over video-call.

Beyond video-aided recall providing more and more detailed player reconstructions of m2m motivations and motivation-game feature links, we saw no major effect.

Our semi-structured episodic interviews (Flick, 2000) focused four broad dimensions: (1) players' m2m *experiences* motivating them to continue or discontinue a play session; (2) *game* factors players connected to these experiences; (3) *personal* factors (like dispositions or biographical situations) players connected to their gameplay; and (4) *contextual* factors (like situation and surroundings when playing). We asked participants to first describe in as much detail as possible their latest recalled experience playing their chosen game, including situational and biographical circumstances. We then instructed participants to identify and describe particular in-game events

that made gameplay engaging (or disengaging) and worth continuing (or discontinuing) (see appendix A).

In video-aided recall interviews (Pitkänen, 2015), we asked participants to play the game they currently actively played for about 5-10 minutes; thinking aloud in the process so that we could take observational notes. We video-record screen activity and player reactions and then conducted a follow-on interview where we replayed gameplay footage and stopped the video at key moments to probe deeper what participants experienced at that moment and what part of the game they ascribed this experience to, using the same guiding questions for m2m experience and game factors. We made observational notes about the interview situation to capture contextual factors.

We collected diary entries (Bolger et al., 2003) initially to unearth patterns and deviations in player experience across game sessions, capture how fluctuations in contextual and personal factors, and player state changes before and after play sessions. We discontinued diaries as they required additional effort from participants yet duplicated the findings from episodic interviews.

We took extra care to avoid ambiguities and over-interpretation around player-reported experiences by asking players to restate the reported experience in different terms, or to provide an alternative example or explanation. Interviews were recorded and transcribed ad verbum along with data collected from online text exchanges where preferred. Following grounded theory principles of constant comparison and theoretical sampling (Charmaz, 2014), all data was coded and memoed as it was transcribed, comparing new information against existing codes and concepts, adding and revising concepts and relations as required by the data and re-coding existing data accordingly, and evolving the interview script and choosing new participants based on emerging questions and hypotheses.

Following our learnings from the previous chapter, we understand feelings of uncertainty as the feeling surrounding knowledge gaps (see Chapter 3). In our data analysis, we record something as uncertainty when the players express feelings of uncertainty irrespective of the source it is coming from. The player needn't use the exact term: 'uncertainty', but express it through feelings around expectations, doubt, predictability etc. From our understanding of epistemic emotion (see Chapter 3) we realise that epistemic emotions are closely related and we acknowledge that each player would express their feelings uniquely through their own chosen words. Amongst

other emotions, these feelings of knowledge gaps could be expressed as doubt, unpredictability, excitement to find novel (unknown) information, feelings of anticipation around a resolved state and feelings related to discovery of missing information. We record a feeling as uncertainty only if the players touch upon feelings of missing information in their gameplay experience and express it so.

Additionally, we consider uncertainty as motivating only when players would show willingness to find more (acquire knowledge) to resolve their gaps in knowledge and show motivation to adapt to the uncertainty. This is in line with Shin and Kim's (2019, pp. 853–874) argument that "humans have evolved to be deeply curious to adapt to a world of uncertainty." Similarly, we record demotivation when the players are not motivated to fill a knowledge gap.

Results

As stated, our present analysis reviewed and reported not any and all forms of reported uncertainty, but only those instances where the players reported that uncertainty motivated them to continue (or disengage from) playing. The following sections will evidence and discuss our findings.

In summary, we found that the feeling of uncertainty in players evokes the fundamental motivation of curiosity to resolve such uncertainty and progress in the game (to find more about the resolved state). We will evidence and discuss in the following passages that the player motivation is particularly strong when uncertainty is balanced such that its resolution process lines with the players' need for competence satisfaction, need for achievements, need for creativity, need to socialise, need for skill development amongst other needs. Overall, we found resolution of uncertainty as a key reason for players to engage in the game's m2m loop.

As will be made explicit in the following sections, our data showed strong links with epistemic emotions like surprise, curiosity, interest and salient features that evoke such emotions like novelty and challenge (link between these emotions are explained in Chapter 3). In all, our data supports *curiosity* as a common motivator across all uncertainty sources, stoked by some perceived information gap, provoking uncertainty-resolving action. The main structure that emerged were seven player-perceived sources of uncertainty, which could be grouped into three categories or stages:

(1) *Game uncertainty*, where uncertainty is produced by the game's content;

(2) *Player uncertainty* relating to the player's process of making decisions, interacting and learning to adapt;
(3) *Outcome uncertainty* arising from how the game responds to player action.

These three form the m2m experiential sequence of how a player moves through the interaction with a game's core loop (Sicart, 2015): the game presents a new game state (1), prompting decisions and actions by the player (2), which results in an outcome (3) that manifests or leads to a new game state (1) (Fig. 8).

In this section, we will present and illustrate each uncertainty source, sequenced by category, and explain when and how it motivates, linking player statements to matching known motivational constructs (summarized in Table 3).

Game Uncertainty

Game uncertainty is uncertainty afforded independently by the game system presenting new or reconfigured content to the player. This kind of uncertainty is linked with novelty that invokes epistemic emotions of surprise and excitement over unexpected (or hopefully anticipated) game content or content configurations, as well as curiosity over what the game will present next.

Content Uncertainty

Content uncertainty is related to the knowledge gap surrounding novel information in the game and thus the epistemic emotions like curiosity, interest, feelings of excitement and anticipation that accompany novelty. This uncertainty is sourced from (1) new content and (2) new goals. The players are motivated (curios) to find more about the new information and resolve the knowledge gap.

(1) Players continue playing m2m as they are uncertain and therefore curious about what they will encounter: "*Although I have not reached too far in the new scene I am curious to see what comes next*", as [p03, g06] puts it. In this case the player just entered a new scene and in every m2m loop (at any moment) is expecting to encounter new game elements. As the player continues to engage with the m2m action-reaction loop, a constant hunger and anticipation to find what is next propels the player to progress. They expect that new information would be made available after their actions in every m2m loop. Similarly, the imagined possibility of encountering

as-yet-unseen content any moment generates excitement: "*what if you find the wardrobe and you go through it and you find another world on the other side, you know that's always been like the most exciting thing for me*" [p09, general]. To sustain both, the game needs to continuously serve novel content; [p08, g12] says: "*I think it manages to keep my curiosity because there are levels after levels and the puzzle doesn't repeat*". The novel content in each level offers information gaps that they wish to resolve as they engage in m2m gameplay. From prior experience with the game or general gaming, players build up some-yet-uncertain expectations about possible new content, like new mechanics, and assess novelty as deviation against that. Players forecast uncertainty that will accompany novel content and make their m2m gameplay engaging, this is where overarching and m2m level uncertainty connect i.e. the general uncertainty of what the new levels or mechanics will be translated to anticipation and excitement in the m2m gameplay loop. As [p06, g09] puts it, "*[I] prefer Two Dots* (Playdots, 2014) *over those [other games] because they became really dull after a while, whereas Two Dots at least there are things that keep changing, whereas those... they don't really change, the mechanics is basically the same.*" Players reported to stop playing when they formed the belief that there would be no more novel content to encounter: "*Overall it was a fun half an hour but I wouldn't return as it didn't promise anything different*" [p10, g14] This uncertainty-from-novelty goes hand in hand with m2m uncertainty about the *timing* of novel or even known content: "*the one that you really want to get is that, is the advert (laughs), that's so clever, I am sitting here every time, please be an advert, please be an advert.*" [p09, g13] Behaviourally, players reported that new *content uncertainty* motivated them to explore the game: "*the kind of exploration element at the beginning of the games, I love when you start and it's all fog around you and you gotta kind of like figure it out and maybe there is something dangerous out there uhm, maybe there isn't but there's really kind of sort of quite always thrilling*" [p09, general]. Apart from players mentioning curiosity verbatim as their motivation to continue play and explore, the structural (novelty) and behavioural (exploration) features they call out all suggest *curiosity* as the underlying motive (Silvia, 2012).

This general motivational construct, usually conceived as an emotion or need, links to player trait/preference constructs like *Discovery* (Hunicke et al., 2004; Yee, 2016), *Seeker* (Nacke et al., 2014), or *Explorer* (Bartle, 1996).

(2) New content (like a new level or opponent) is often accompanied by or constitutes new goals, which players again found engaging. In the moment when a player is moving between levels in their m2m gameplay loop, they exclaim: "*Excited to be going to the next level. A new level promises to bring a*

new level of difficulty and new goals" [p03, g06]. Such new goals can be explicit (as in a new quest) or self-generated by players: "*maybe as they added new islands I would want to conquer the new one*". [p07, *Pirate Kings* (J. B. Games, 2018)]. Players clearly identified a stream of new and changing goals (and the prospective expectation thereof) as a motivation to continue playing, in line with motivational research on *goal-setting*: well-formed goals motivate people to work towards them (Locke & Latham, 1990), which is mirrored in player preference constructs like Yee's *Completion* (Yee, 2016). This ties into uncertainty directly - new goals are uncertain novel content themselves - and indirectly, in that new goals are needed to challenge the player, forming a prerequisite to *player uncertainty* (see below).

Overall, we recorded *Content Uncertainty* relating to the emotion of uncertainty that players felt and wanted to resolve when they saw or anticipated new content. This happens in the m2m gameplay when players have just encountered, are just about to encounter new elements or are very close to unlocking new content. In some cases, an overarching feature like a new island is exciting to players and impacts their m2m gameplay and m2m motivation. This is observed as m2m as players while taking an action ask questions like 'what if I find/discover', 'what will the next challenge (goal, elements) be [I should prepare for it *now*]'

Configuration Uncertainty

Beyond entirely new content, players are uncertain about novel configurations of already-known game elements. Here, curiosity-inducing uncertainty as the difference between experience-based predictions and actual content becomes even more pronounced. As [p11, g15] explains, "*it adds quite a lot to my experience ... one-identify the pattern; two-execute that pattern, and then do that while you recognise the next pattern after that. There's a lot of being able to, uhm, predict, with a degree of accuracy, what the next thing the game is gonna need you to do ... now that's where the next gap is', so it's a very seesaw process of, like - 'Where's the gap?', 'What are these gaps telling me about the sequence that is coming up?*'" In fact, players report implicitly testing their own ability to predict new game content as part of their gameplay skill, deriving engaging satisfaction from accurate predictions, which matches *competence need satisfaction* as a motive described in self-determination theory (Ryan & Deci, 2000). "*You have the rhythm of the level and that kind of gives you an idea, the locations of the fruit - you can't say, guessing that makes it more fun, a completely predictable game will not be fun for long*" [p03, g05]. Again, this uncertainty often revolves around or prompts new goals and challenges: "*I am focused on the game and the upcoming obstacles and the unpredictability definitely keeps me focused on the game at*

the very moment" [p03, g06]. The deviation of content from built-up expectations (and connected solution strategies) makes it an interesting challenge to the player's ability, prompting the next form of uncertainty, *player uncertainty*: "*That was uncommon pattern, the moment I saw that pattern I had a split second of hesitation that I didn't recognise it. ... Had I beaten this I would be feeling pretty smug*" [p11, g15].

We recorded *Configuration Uncertainty* when players reported they felt uncertainty when presented with new patterns or they anticipated new patterns. This happened in their m2m gameplay when they just encountered a new pattern or are about to. They try to predict and the manageable unpredictability keeps them engaged. The players during their m2m gameplay remark on the lines of 'What will the next pattern be', 'can I predict the coming pattern', excitedly exclaiming 'this pattern is unexpected' showing m2m motivation.

Player Uncertainty

This category captures the player's experienced uncertainty sourced from their own *decisions* (what to do and how), *interactions* (how well they can do it), and ability to *adapt* (whether they are able to grow and learn in the process). It refers to the feelings players have right before the actions and during the actions they take in an m2m action-reaction gameplay loop. This kind of uncertainty is strongly linked with the epistemic emotions of: feeling of doubt/confidence, feeling of competence, feeling of error, feelings of agency, tip of the tongue feeling, feeling of excitement to execute a skill.

Decision Uncertainty

Players reported being uncertain about what actions to take in what order when the game offered multiple alternatives. This could be choosing from options in a branching story, deciding between ducking or jumping on countering an obstacle, or simply when to hit a button: "*How hard to hit the ball, which direction it should go in ... you have to recognise them [the coming patterns] ... in the right time, and then counter it with similar decision-making*" [p01, g01]. In this quote, a player explains their decision making process and questions as they were about to take a golf shot while time was ticking. In the moment, the player must make some decisions or decide to act randomly before they lose their chance. This *decision uncertainty* is enabled by new goals and challenges posed by new content and configurations (see above), but also ties directly to the resulting uncertain outcome. In the moment, making decisions and predicting outcomes is experienced as directly connected: "*It would be, how much you want to hit, where you want to aim,*

how much you think it will bounce and where you think it will go plus the timing. It's everything included". [p01, g01]

As most pick-n-play games are rather linear and lack complex interactions between mechanics and decisions, they don't offer as broad and deep a network of interacting decisions to make as e.g. strategy games. Still, players reported being motivated to test their decision-making skills, strategies, and progress towards a goal, curious to see how their decisions turn out. Players frequently used the word "meaningful" and the emphasis is on being in control (autonomous) to capture particular instances of resolving *decision uncertainty* that were motivating: "*They [the decisions] are extremely meaningful because it's, like-all I've been given is a set of obstacles; it's totally up to me how I want to actually engage with them.*" [p11, g15] As this statement indicates, for the decision making process and thus accompanying *decision uncertainty* to be meaningful, players need to experience a *sense of agency* (Haggard, 2017): they are in control of the decision and feel free to make it. In addition, that decision needs to have an expected impact on an outcome in the game "*[you] couldn't really have a more meaningful choice than somethings that's like 'Am I going to do something with a certain amount of risk that might kill me?*" [p11, g15], notably an outcome the player cares about: "*so the choices you make are essentially, affect the outcome of the game, so it does make you engaged because you are concerned with the outcome of the game*" [p01, g01]. Another way of parsing the motivational pull of such decisions is *autonomy need satisfaction* as construed in self-determination theory (Ryan & Deci, 2000): being able to make choices that matter to them, players feel that they act from a perceived internal locus of causality, with volition and willingness. In addition, decisions are motivating by the thrill of testing one's competence: "*there was a decision: to just see if I can make it... that's quite thrilling, because it's like 'Oh, I did make it!'*" [p11, g15]. This illustrates the crucial tie between decision making and anticipation of outcome. In short, *decision uncertainty* is "meaningful" as in engaging when players perceive that (1) they have a choice they are in control of and this choice will impact the game state in a way that matters to the player (sense of agency and/or autonomy), which is enhanced when the decision promises to (2) test the player's competence. A lack of perceived choice or feeling of helplessness led to disengagement, as stated by [p06, g09] about not wanting to play a level: "*I've had levels basically where the entire screen was almost covered in flame and there was absolutely no option.*"

Compounding immediate 'low-level' decisions, players reported *decision uncertainty* in arranging multiple actions ("*lining it up so that, then I can try to get a perfect shot and if I get a perfect shot then all this would align and then*

the ball will go wherever I want it to go" [p01, g01]) or juggling between different longer-term strategies in the moment: "*I wonder if I can out that [collected resource] towards making some big leap or it might be ready to prestige now, you know or maybe in an hour or when I go to sleep*" [p09, g13]. Beyond agency, autonomy, and competence, this engaging quality of strategic decision-making fits the *Strategy* sub-component of Yee's motivational model (Yee, 2016).

We recorded *Decision Uncertainty* as the feeling of uncertainty players expressed they had just before taking actions which would be resolved by taking the action. This the decision making motivated players to continue playing to see how their decisions panned out. Overall it strongly connects with the feeling to validate competence and feelings of agency in making decisions. The players expressed or recalled their emotions during m2m gameplay with remarks on the lines of: 'what choice should I make', 'I am free to choose so what should I decide', 'what strategy should I opt for' showing engagement in the moment of play and thus motivation towards continuing to see the game's reaction.

Interaction Uncertainty

Interaction uncertainty regards players' practical ability to perform a chosen action. This links to the excitement around uncertainty of performance in the face of challenge. Players are uncertain if they can execute an action timely and accurately to influence the outcome in their favor. The required timing and accuracy tests and thus stokes uncertainty about the player's skills: "*There's a pretty high chance that actually I'm probably not gonna make it in time unless I was actually quick enough to pick up on it ... I've totally internalised that, so it's more like 'Get, get to the gap' and, sometimes, I overshoot or undershoot - isn't that just another skill-level thing*"[p11, g15]. This player is sharing their experience with the game *Super Hexagon* (Cavanagh, 2012) which they played in front of the researcher and also did a video recall interview. Here they are explaining the unpredictability they feel with respect to their interactions as they are executing the action of aligning the game pointer with a gap. They are aware of the skill needed for the game and are continuously trying to act accurately to not lose the game. The uncertainty they feel in the moment expressed by saying, 'probably not going to make it' shows that they feel a knowledge gap in their own interaction abilities. This is echoed by other players during their m2m gameplay (see below). Since the challenge in this case was well balanced with the player's skills they were motivated to face this uncertainty and resolve it. Other skills tested included multitasking and attention-switching between e.g. present and upcoming challenges ("*If I were uber awesome I should probably check the*

top, so I can better react to the coming challenge" [p09, g13]), and learning controls: "*The control is only clicks, which I do with my left thumb. I have tried switching fingers to see what works best, and landed on this. This was through the evaluation of the scores I made and the general stability of my character during that level*" [p03, g06]. Players reported being immediately motivated by curiosity in the extent of their own abilities and how to control the game.

In addition, if game feedback tells players that they succeed, they consequently experience what can be construed as *competence need satisfaction* (Ryan & Deci, 2000) or *Mastery* (Yee, 2016): "*...the points where I tap in quick succession, feeling like the expert*" [p07, g11]. This is the link that shows that such an uncertainty is linked to motivation of the players (motivations linked with perception of competence) to progress in the game.

Especially in real-time game, the sheer risk of losing at averting one's attention briefly motivated m2m continuation: "*... the fact that you get the tasks to complete really fast one after the other one is something that keeps you stay and playing*"[p08, g12]; "*...but, the chance, like-I often feel, like, the moment I can and take my foot of the pedal to go like 'Oh, yeah!', like, I've probably just died*" [p11, g15]. The unresolved ongoing tension of losing risk coincided with higher levels of arousal, fitting Yee's *Excitement* motivational sub-component (Yee, 2016).

We recorded *Interaction Uncertainty* as the emotions players exhibited while taking an action in the m2m gameplay loop and being uncertain about their own performance abilities, however, being excited to also know how they performed. This kind of uncertainty is closely related to excitement of taking actions and observing one's skills. The players' remarks echoed the following underlying sentiments: 'will I be able to act accurately and timely?', exclamations like 'that is so fast!' and confidence of 'I can do this'. The feelings of confidence, perceived competence and excitement of action when posed with *Interaction Uncertainty* motivates the players to engage in m2m gameplay.

Adaptation Uncertainty

We observed that closely related to *Interaction Uncertainty* is uncertainty of adaptation or performance growth beyond each individual interaction. Players are uncertain how well they can adapt to the game's challenges. They are uncertain if they will be able to tackle a challenge, as a player describes, "*Trying to see if I can catch that extra fruit this time, now that I know that is coming. Will my reaction be as fast as the game throws fruits at me. ... Mine [their motivation] is this. To score better each time*" [p03, g05]; "*I'm trying to*

get to the situations which I feel I could do better at in comparison to my previous runs and then see if I do" [p05, g08]: in the m2m gameplay of a puzzle, this player is constantly trying to improve upon their performance and judge their mastery and growth. To fuel such motivations to display *achievement* (Brunstein & Maier, 2005) or experience *competence* (Ryan & Deci, 2000), tasks needed to be perceived as challenging, that is, their desired outcome given the player's self-perceived skills was seen as uncertain: " *I want to see if I can keep the character steady enough to not get killed*" [p03, g06].

Players also explicitly framed this as curiosity in their abilities: "*I had a streak, and I was good, and, like, now I've satisfied my curiosity about whether or not I could do it further*" [p11, g15], or as another player puts it "*[I] want to see how far can I reach? Can I reach the next level. Every level has an instruction and goal at the beginning and I wanted to see if I can reach that goal*" [p03, g06]. The player in this quote is sharing their experience while playing a fast paced platformer, they are resolving Interaction Uncertainty while also testing their mastery and accessing 'how far can they reach'- this question of how well have I adapted to the game world motivates this player to resolve this question in every m2m loop of gameplay by continuing to play.

Players are motivated to continue as they are not fully certain if there is more they can learn, as one player remarks in line with Koster's *Theory of Fun* (Koster, 2013): "*as soon as you learn everything in a game, there is no reason to play*" [p05, g08]. Independent of curiosity about their current ability, this also shows curiosity in what there is to learn as part of a given game (Silvia, 2012).

We recorded *Adaptation Uncertainty* as the feelings of uncertainty pertaining to accessing oneself and one's growth in the ability to play a game. This kind of uncertainty is closely linked to the feelings of mastery, feelings of improvement and feeling of achievement along with the feelings of competence. While explaining this emotion in their m2m gameplay players remarked on the lines of: 'am I getting better?', 'How much better am I reacting to a challenge?'

Outcome Uncertainty

This category captures uncertainty over not knowing the game's or another player's reaction after the player has performed their action: (1) game-related *result uncertainty* and (2) other-related *opponent uncertainty*. Players are curious about what is going to happen, whether they predicted the outcome correctly, and whether they accomplished affecting a desired

outcome. Thus, *outcome uncertainty* is tightly connected with player and game uncertainty. This kind of uncertainty relates to the importance of feedback in games (Marczewski, 2013) and players' emotions of anticipation and emotions of curiosity and interest in the game's reaction.

Result Uncertainty

Players describe game results of their actions to be motivating if they are neither too predictable nor too unpredictable, for example once a player has taken a shot in a golf simulation game, they say: "*I should be at least able to, say if I played 20 times, I at least say 50% of the time I should be able to get a perfect shot...*" [p01, g01]. A completely predictable outcome is reported as disengaging: "*A completely predictable game will not be fun for long*" [p03, g05]. On the other hand, players feel no control if the outcome is fully unpredictable: It is "*definitely not fun*" that "*in the shootout, you can't predict at all*" [p01, g01], or as another player reports: "*I just couldn't really get on with it in the sense that, yeah, there was none of this sense that I was in control, and I couldn't predict what was gonna happen next.. I would consider myself quite an experienced gamer - and even with that... I still couldn't work it out.*" This could make the game outcome appear: " *I'm thinking if I'm losing in a game is 'Oh, the game's decided we are going to lose now'*" [p12, general].

Players generally prefer that the outcome relies on their skill rather than something they can't control: "*... if it were skill then it would have been (rewarding) but I don't know what you need to do to make it a perfect shot. I think it's timing, if the arrow goes and you have to time it, but there is no real way to gauge*" [p01, g01]. While luck was reported as a positive experience ("*The thrill that I got lucky, whenever the right card came along*" [p07, g10]), players are disengaged if a game's outcomes are 'too' random for them: "*I got bored of it. It's a very, very simple game, and it's a bit too much based on randomness*" [p04, g07].

In such instances with not 'too much' luck, resolving *outcome uncertainty* would also resolve *player uncertainty* about and curiosity in their own skill overall: "*I would clearly know if I am playing better or not, because I am doing something wrong and then I can fix that. Either by playing a lot or by something*" [p01, g01]. Relatedly, it satisfies the player's curiosity in their ability to predict their performance. A healthy amount of performance predictability keeps players in the 'right' zone suitable to each player. As a player describes, "*I very rarely get frustrated with logic puzzles cause I know I can do them... cause logic puzzles all generally follow the same sort of pattern.... So, I know, eventually, I will get through it*" [p12, g17]. However, this basic expectation of competency should not tip over into certainty of success: "*if I*

knew I could do it I would do it and then move on to something I can't do" [p05, g08].

Connected, resolving *outcome uncertainty* would resolve uncertainty about self-set or game-set goals and expectations: "T*he expectation was within 60 seconds. I took 38 seconds*" [p03, g06]. Thus, where player uncertainty taps *competence* (Ryan & Deci, 2000), *mastery* (Yee, 2016), and *achievement* (Brunstein & Maier, 2005) in the form of expecting or wanting, *outcome uncertainty* provides satisfaction on beating and the opposite on failing expectations: "*I get disappointed when I go less than I thought*" [p10, g14]. Beating expectations also afforded positive surprise: "*The first time it did that I freaked out ...when I tap instead of getting like 10 dollars or whatever it is, I am getting starting with 2AD meaning that like on my first*" [p09, g13]. This cycle of acting, expecting and outcome reveal keeps players engaged from m2m: "*from moment to moment I want to see if I can keep the character steady enough to not get killed*" [p03, g06]. In the above example quotes players are uncertain about the results of their interactions and they look forward to the resolution of that knowledge gap i.e. the results of their actions and then relate it to their expectations.

Outcome uncertainty connects to and resolves *decision uncertainty* in the same way, as it satisfies player's curiosity how their decisions pan out: "*so the choices you make are essentially, affect the outcome of the game, so it does make you engaged because you are concerned with the outcome of the game*" [p01, g01]. This entails resolving uncertainty about the relative size of the decision's impact: "*how much you think it will bounce and where you think it will go plus the timing*" [p01, g01].

Finally, resolving *outcome uncertainty* feeds forward into *game uncertainty* in the form of anticipated new content and goals: "*I get to have other new tasks if I get to a higher score*" [p08, g12]. Players are eager to see the outcome to plan further: "*if we get one more thing up to eleven hundred, then I get plus two hundred percent on everything, that's pretty significant... I'd like to get either the theme park or the bank to (upgrade)*" [p09, g13]. Some players would seek out all possible outcomes as they were curious in the different content they provided: "*And I played it through a class each, so the different character classes, and I played it through to try to get the different endings*" [p06, *Vampire: The Masquerade* (WhiteWolf, 1991)].

A player summarizes the importance of the outcome itself and the related uncertainty - "*[I want the game to] show areas I would not immediately expect from the core mechanics ... if the game manages to give me moments where I*

care about what happens, it's worth to keep playing if that feeling dies down over time or never comes up, I don't bother" [p05, g08].

We recorded *Results Uncertainty* as the uncertainty that the player feels about the upcoming outcome right after performing their actions. This is tightly linked with the motivation and emotions of achievement and perception of competence. While engaging in m2m gameplay, the players emoted in the lines of 'did I win?' and comparative emotions like 'Am I better than before?'

Opponent Uncertainty

This category captures uncertainty over an opponent's or collaborator's reactions in a multiplayer game. Players plan based on their expectations of the opponents plans and abilities: "*You can see the other guys amassing troops at your borders, you don't know when they're going to attack, so you're shoring up defenses*" [p07, Risk (S. M. G. Studio, 2017), the player explains their actions as they read the opponent's reactions. This also stokes *decision uncertainty* about the players' own strategies - which one to choose and how it will resolve: "*you probably have a strategy as to how you're going to break into the other guys camp and take over all his territory and these are strategies over a few moves, so you're definitely invested in a few turns*" [p07, *Risk* (S. M. G. Studio, 2017). Players are also uncertain of their opponent's skill, which keeps them guessing the outcome of the game: "*... depending on the other player's skill you may be able to win*" [p01, g02]. Moreover, they are uncertain about the moves the other will perform each turn: "*Obviously there are chances the other player will also make a mistake*" [p01, g02], over here after taking their turn, the player's immediate thought is how well will the opponent perform- this motivates them to see the reaction of the opponent to their actions. Players stop playing if they feel matched with another in such a way that they can already predict the outcome: "*I sometimes blame the matchmaking algorithm for teaming us against someone who's really good*" [p12, general].

Along with the other motivations attached to *outcome uncertainty* already mentioned, interacting with others can create social motivations like *relatedness need satisfaction* (Ryan & Deci, 2000) or *achievement* (Brunstein & Maier, 2005), connected to player preferences captured in Yee's *Social* competent (Yee, 2016).

We recorded Opponent Uncertainty as the uncertainty player's felt regarding the reaction of another player. They wanted to resolve this uncertainty by accessing the opponent's move. This kind of uncertainty also deals with feelings of comparison in a social setup and the feelings of exhibition. The

players' remarks echo the questions around: 'how will the other perform', 'am I better than them?'

Discussion

We recorded the above types of uncertainty as m2m because players reported that they triggered their motivation to engage with the m2m gameplay. Even if some uncertainties are more related to overall game experience looking forward to new levels, we report them only when such uncertainty informed the player's m2m gameplay in our observation.

Zooming out, we see three contributions our data makes to the current discourse around game uncertainty: (1) it presents an uncertainty taxonomy that is grounded in naturalistic observation, corroborating and challenging existing theory-led taxonomies; (2) it explicates conditions *when* certain uncertainty types become motivating as well as the underlying motivations explaining *why* these types of uncertainty propel players m2m; (3) it identifies novel uncertainty types, especially *game* and *outcome uncertainty*, which were insufficiently captured in previous models.

Sources of Uncertainty

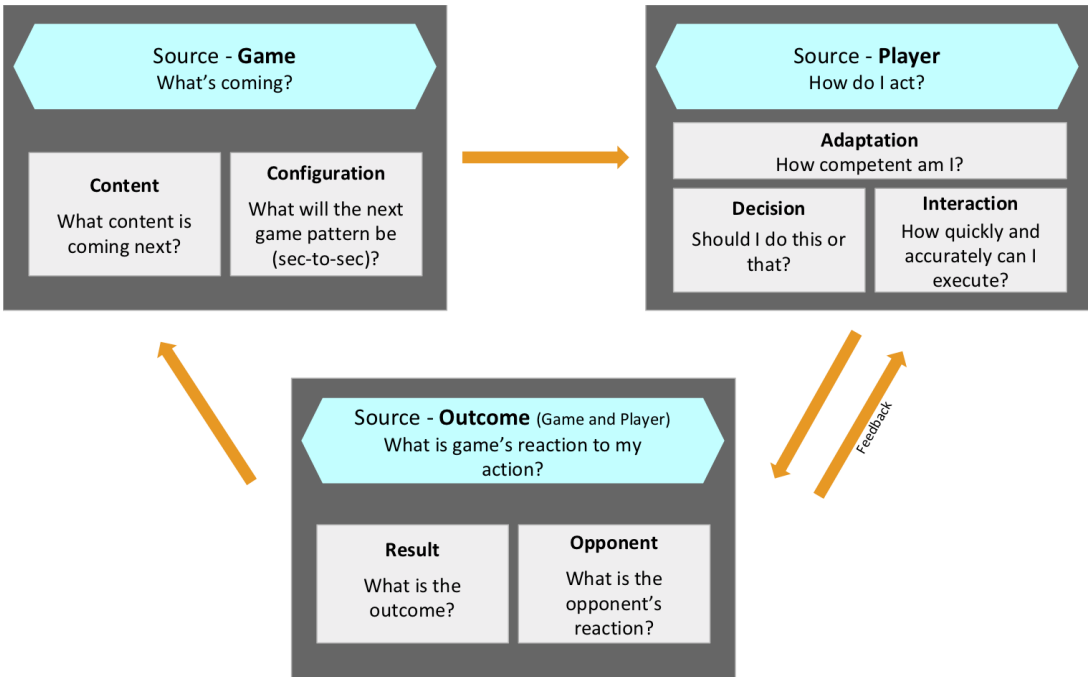

Fig. 2. Relationship between the sources of uncertainty

Our data provided a taxonomy of game uncertainty sources grounded in the m2m phenomenal experience of 'going through' a game's core loop in the

course of seconds (Fig. 2) as opposed to solely 'summative post hoc' recording of experience as done in PUGS (Power et al., 2019). The data is drawn at an m2m level observations and video recalls that players explained about their m2m motivations to engage with the gameplay. (1) Players experience *game uncertainty* over what novel content and content configurations the game will present to them, which entail implicit or explicit new goals. (2) Players then experience *player uncertainty* over their own reaction to the game's new material: what actions to take, how they will and should execute on their choices, and whether they bring the competence to do both well. (3) As the players ponder and perform actions, they experience *outcome uncertainty* about what the outcome of their actions would be. They want to see how their decisions, actions pan out, how good they actually prove to be, and what new content may be unlocked as a result. Overall, these three sources of uncertainty work in a tight loop of game prompt, player action, and game reaction. This is supported e.g. gambling research (G. H. Weiss, 1979) finding a link between *decision* and *outcome uncertainty*, and Johnson (2018) observing that *game uncertainty* informs player actions. Costikyan (2013) has a concurrent running commentary throughout his book that information gaps in the game lead to player's uncertainty.

Causes and Conditions of Motivating Uncertainty

As illustrated in the section above (summarised in Table 3), amongst other motivational constructs, curiosity which is a well identified motivational construct within games (Garris et al., 2002; Lazzaro, 2004) and outside, (Berlyne, 1960; Paul J. Silvia, 2012) comes out as a common motivator across all uncertainty sources which falls in line with our current understanding of curiosity being evoked by uncertainty and the need to solve it (Litman & Jimerson, 2004; Loewenstein, 1994; To et al., 2016).

Uncertainty Source	Uncertainty Type	Conditions (When)	Motivations(Why)	Exemplary player thoughts
		Game loop creates anticipation for new content.	Curiosity (Silvia, 2012; To et al., 2016)	What's next? What if?
		Game loop creates anticipation of new goals.	Goal-setting (Locke & Latham, 1990) Achievement (Completion) (Yee, 2015, 2016)	What will the new goals be? Will I want to complete those goals?
	Content	Game creates opportunity to explore (e.g. fog of war).	Creativity (Discovery) (Yee, 2015, 2016)	What new things could I find?
		Game produces ongoing new configurations.	Curiosity (Silvia, 2012; To et al., 2016)	What will the new patterns be?
		Game enables mastery in predicting patterns.	Competence Need Satisfaction (Przybylski et al., 2010; Ryan et al., 2006; Ryan & Deci, 2000)	Can I predict coming patterns?
Game	Configuration	Game creates surprise with novel patterns.	Excitement (Action) (Yee, 2015, 2016)	I didn't expect that pattern.
		Player is presented with an impactful choice.	Curiosity (Silvia, 2012; To et al., 2016)	What choice will I make?
		Player is presented with a perceived free choice.	Autonomy (Ryan et al., 2006; Ryan & Deci, 2000), Sense of Agency (Haggard, 2017)	I am free to act in tune with my goals, values and identity.
	Decision	The player can plan ahead.	Strategy (Mastery) (Yee, 2015, 2016)	What strategy or sequence of decision should I take?
			Curiosity (Silvia, 2012; To et al., 2016)	Will I be able to act accurately and timely?
			Excitement (Action) (Yee, 2015, 2016)	That's so fast!
		Player needs to react to a game's event.	Competence Need Satisfaction (Przybylski et al., 2010; Ryan et al., 2006; Ryan & Deci, 2000)	I interact competently.
	Interaction	Player wants mastery following game's difficulty curve.	Achievement (Mastery) (Yee, 2015, 2016)	I am mastering this.
			Curiosity (Silvia, 2012; To et al., 2016)	How well can I adapt to challenges?
			Achievement (Brunstein & Maier, 2005), Achievement (Completion)(Yee, 2015, 2016)	Can I achieve all goals set out?
			Mastery (Yee, 2015, 2016)	Am I getting better?
Player	Adaptation	Player is curious about their ability to perform a task.	Competence Need Satisfaction (Przybylski et al., 2010; Ryan et al., 2006; Ryan & Deci, 2000)	Am I able to adapt competently?
		Player is eager to see the outcome.	Curiosity (ilvia, 2012; To et al., 2016)	What is the outcome of my actions?
			Competence Need Satisfaction (Przybylski et al., 2010; Ryan et al., 2006; Ryan & Deci, 2000)	Is the feedback on my performance positive?
			Mastery (Yee, 2015, 2016)	Am I a master? Can I get there?
	Result	Player is eager to see how well they did.	Achievement Theory (Brunstein & Maier, 2005), Achievement (Yee, 2015, 2016)	Did I win/ achieve goals? Am I closer to these targets?
		Player is eager to see another player's reaction.	Curiosity (Silvia, 2012; To et al., 2016)	How will the opponent (or other player) react?
Outcome	Opponent	Player is eager to compare progress	Social (Yee, 2015, 2016)	Am I closer to winning against them?

Table 3. Links illustrating conditions *when* uncertainty types are motivating and *why*

Game Uncertainty

We observe that *Content uncertainty* fuels curiosity when a player's previous experience or experience of the current game loop creates anticipation for new content in comparison to their expectations. Players are motivated by a sense of discovery if the game provides opportunity to explore for content. New content creates motivation to set self-goals or achieve game-goals. *Configuration uncertainty* stokes curiosity when players expect the game to produce new patterns. It also motivates players to continue as they want to see if their competence of predicting game patterns and the excitement when they find something unexpected. This makes players expect more surprises as they continue to play.

Player Uncertainty

When it comes to decision making, we observed that players feel motivated if they are presented with an impactful choice - it makes them curious about the choice they would make, if they perceive this choice as free they further feel autonomy and a sense of agency that they are influencing the changes in game state. If players react with this sense of agency they feel their skill is valued, helping them to feel competent. They are curious to see if they are able to interact skillfully, and are excited to follow the game's action reaction cycle. *Adaptation uncertainty* keeps players curious about their ability to perform a task as they play the game, this additionally invokes the motivation to achieve, to seek mastery, and thus evaluate their competence.

Outcome Uncertainty

Uncertainty regarding the outcome creates player curiosity. An outcome whose uncertainty is not too dependent on randomness (so it can test/express skill), and that is not neither too certain nor too uncertain keeps players engaged and motivated to see the results. This feedback into their perceived competence, sense of achievement and mastery, motivating players to engage further in the game's loop with a new content cycle. Playing with other players adds human unpredictability in the reaction creating a social motivation to engage in addition to the others.

Comparison with Existing Typologies

In this section we illustrate how our results match with and deviate from prior work classifying game uncertainty (Table 4). This mapping is based on our own reading of the literature to the best of our ability.

Model	**Uncertainty Types**						
	Game		Player			Outcome (Game and Player)	
Our Model	Content	Configuration	Interaction	Decision	Adaptation	Result	Opponent
Costikyan	Hidden Information Narrative Anticipation	**Perceptual Uncertainty** Narrative Anticipation	**Performative Uncertainty** Narrative Anticipation	Solver's Uncertainty Analytical Complexity Narrative Anticipation	Perceptual Uncertainty Performative Uncertainty Narrative Anticipation	**Randomness** Narrative Anticipation	**Player unpredictability** Narrative Anticipation
Caillois						**Chance**	Chance
Johnson	Chance Randomness Instability	Chance Instability				Luck Chance	Luck Chance
Power et al	Exploration		Taking Action	Decision Making Problem Solving	Taking Action Problem Solving	Decision Making External	External

Bold - strong mapping

Table 4. Mapping of our uncertainty model against prior work

Player Uncertainty

While Caillois' and Johnson's models do not discuss *player uncertainty* explicitly, it overlaps significantly with categories proposed by Costikyan (2013) and PUGS (Power et al., 2019). Our *interaction uncertainty* maps neatly onto Costykian's *performative uncertainty*, performing accurate physical interaction, as does *decision uncertainty* with both *analytic complexity* (strategic decision making with regard to several possible alternative plans) and *solver's uncertainty*, finding one correct solution, as in a puzzle. Interestingly, Costykian misses out the most basic *decision uncertainty* of how to act next (e.g., 'should I run or jump?' in *Super Mario Bros.* (Department, 1985). Moreover, in our data, players didn't voice experienced distinctions between *analytic complexity* and *solver's uncertainty*.

Moving on to PUGS, *player uncertainty* loosely maps with three factors of the PUGS scale (Power et al., 2018): *Uncertainty in Taking Action* (*UTA*) maps our *interaction uncertainty* and *adaptation uncertainty*. By its name, one would expect *Uncertainty in Decision-Making* (*UDM*) to fit our *decision uncertainty*, which revolves around identifying 'optimal' actions, decisions, and strategies. Only one of the items in PUGS *UDM* factor captures this quality: "I could not choose which actions were better". The rest of the items revolve around players being uncertain if their actions are impactful or in any way connected to the outcome. Our data suggests that players only experience *decision uncertainty* to be motivating when their decisions are perceived to be clearly 'meaningful' as in having a clear impact on the outcome. Thus, a game could score high on the PUGS *UDM* factor and be demotivating, as the factor conflates (engaging) uncertainty about which option to choose with (disengaging) uncertainty about whether said choice will have an impact.

The third PUGS factor connected to *player uncertainty* is *Uncertainty in Problem-Solving* (*UPS*), capturing whether players understand the game and how it is to be played. We did not find instances of this in our data, presumably for three reasons: (1) it will likely show with inexperienced players new to a game, while our participants reported on games they were already familiar with; (2) it focuses a macro level as opposed to our investigation of the m2m level; (3) it again captures a likely undesirable, dis-engaging form of uncertainty, where we focused motivating uncertainties. In summary, existing models do not capture the interaction nuances of *decision uncertainty* and do not report *adaptation uncertainty* as a stand alone category thus not discussing it in much detail.

Game Uncertainty

In our model, *game uncertainty* encapsulates *content uncertainty* and *configuration uncertainty*. The closest match to *content uncertainty* is Costikyan's *hidden information*, the uncertainty of not fully knowing the game state, like not knowing what cards an opponent holds, although notably this does not extend to uncertainty about entirely new content, which featured strongly in our data. Costikyan's *uncertainty of perception* captures uncertainty around the player's current grasp of the game state, which somewhat maps with *configuration uncertainty* (in terms of knowing the game state) and *adaptation uncertainty* (in terms of the player's ability to grasp the game state). But again Costykian is more focused on how this uncertainty tests a player skill and overlooks the curiosity value of novel game states. Johnson's *randomness* captures unpredictability in the starting conditions of a game. This partially maps with *content uncertainty*, but only at the stage where players talk about initial game content, not the ongoing stream our players reported on. In PUGS, the 2-item *Exploration* (*EXP*) subscale maps with the exploration behaviours players reported on *content uncertainty*; however the items do not speak to uncertainty of new content or configurations that the game presents unprompted. In short, existing models capture *game uncertainty* very partially, missing out on *configuration uncertainty* and *content uncertainty* around new content generated by the game unprompted.

Outcome Uncertainty

Outcome uncertainty of our model is uncertainty in how the game (*result uncertainty*) or other player(s) (*opponent uncertainty*) reacts to the player's actions. Costikyan's *player unpredictability* matches the latter: the inability to predict what other players will do in a multiplayer game. *Result uncertainty* in our proposed model goes notably beyond Costikyan's *randomness*, which refers to uncertainty where the outcome depends on a probabilistic process. Players in our study report being curious about how the game will react to whatever action they perform, no matter if said reaction is partly or fully randomised or not. An item on PUGS *UDM* captures the *outcome uncertainty* of players not knowing if the game has multiple outcomes, players did not report this in our study even when they talked about games with multiple endings. *EXU* explores the role of chance in the game and effect of random elements on players, similar to an aspect of *outcome uncertainty* of players not being able to predict what the outcome of their actions would be and how that would feed back into their own performance. However, *EXU* does not address the uncertainty and curiosity around what the game's reaction would be when the players have used skill.

While Caillois does not propose a detailed uncertainty typology his play category of *alea* or *chance* aligns with *result uncertainty* in our model. He says, "for nothing in life is clear, since everything is confused from the very beginning, luck and merit too" (Caillois, 2001), carefully addressing that challenge and chance although the opposite must also be complementary. This maps directly with our findings that whether the game is more skill based or more luck based, the outcome of a game event must be somewhat uncertain, for the gameplay to be engaging. Johnson's *chance* is unpredictability that occurs during the play of a game, such as an unpredictable move made by a non-player character. Any unpredictability sourced by the game during gameplay is grouped under *chance* including uncertainty around the result of a game event, for instance the unpredictability of the outcome of a die roll in the board game, *Snakes and Ladders*. Thus all kinds of *game uncertainty* and *outcome uncertainty* of our model is basically *chance* in their model. *Luck* is unpredictability at the end of a game, where *luck* is the extent to which player action can influence the outcome of the game. *Outcome uncertainty* at the end phase of the game maps with *luck*.

Summary Comparison

Overall, Costikyan's (2013) eleven sources of uncertainty map most strongly with our model. One important divergence (among the smaller ones outlined above) is Costikyan's broad category of *narrative anticipation*: the desire to find out how the story or play arc of a game unfolds. It cuts across *game*, *player*, and *outcome uncertainty* in terms of players wanting to see new content and how the game and others respond to their actions. This was not reported as a collective anticipation by players instead as anticipation around each category of uncertainty described in the model.

PUGS developed by Power et al. (2019) aims to measure uncertainty as a "foundational experience" of gameplay, which they are then interested in manipulating by e.g. increasing or decreasing "fog of war" (Kumari et al., 2017). Their categories show little overlap with ours because (a) they descriptively focus *any* kind of uncertainty, where our model captures *engaging* uncertainty, (b) they are interested in summative dimensions of overall gameplay, whereas our model disentangles a phenomenal sequence of causes and experiences in m2m gameplay, and (c) their model is limited to assessing structures within items proposed by prior theoretical models, where our model is grounded in open naturalistic observation.

Johnson's (2018) nomenclature proposes an analytic distinction of unpredictability according to phases in a game; this again leads them to not capturing any *player uncertainty*.

Overall, while our empirically grounded model supports several prior theoretical categories in existing models, it goes beyond their scope identifying novel uncertainty types like *content*, *adaptation* and *outcome uncertainty*. And focusing on the m2m loop of uncertainty in games, their conditions, and the motivations explaining *why* different sources of uncertainty lead to better player experience, it arguably advances our ability to guide game designers in affording engaging uncertainty in games.

Overall Discussion and Conclusion

We conclude that if researchers are interested in macro aspects of uncertainty like the overarching feeling of *disorientation*, *exploration*, *prospect* and *randomness*, they can indeed manipulate it at a game level and measure it using the zoomed out lens of PUG (Power et al., 2019). We suspected that there is more to uncertainty than how it affects overall gameplay, that it participates in players' repeated play loop at a m2m level where it interacts with many known aspects of player motivation and propels the player's will to continue playing.

In this study, we presented a grounded theory of how game uncertainty affects players' m2m motivation in games, based on qualitative episodic and video-aided recall interviews. We found that uncertainty plays a key role in motivating players to continue playing from one moment to another being engaged in the m2m action-reaction gameplay loop. We developed an empirically grounded taxonomy of seven sources of uncertainty across the input-output loop spanning the game, the player, and their interaction in an outcome. With this we contribute to *when and why* uncertainty motivates showing that uncertainty types are not isolated but inform each other in a continuous loop keeping the players engaged. For instance, game uncertainty about new elements and patterns motivates players to resolve this uncertainty by interacting with these elements and patterns; interacting with them raises uncertainty around decision, interaction and adaptation and to resolve that uncertainty player's are motivated to perform the interaction; they are then interesting in resolving the uncertainty of the outcome of their actions; this outcome would lead to new game state looping back to game uncertainty. The *when* being the three main stages within the m2m loop- game, player, game's reaction and the *why* broadly being the motivation to resolve the knowledge gap feeling a number of varied epistemic emotions

connected with each stage. This taxonomy partially maps onto existing taxonomies, especially that of game designer Costikyan, providing converging evidence for their validity, as well as highlighting certain aspects overlooked by existing taxonomies. This has helped us look at the existing work on uncertainty in a new light and resulted in extending and clarifying well known prior taxonomies. We were also able to tentatively link different uncertainty sources to corresponding existing motivational constructs, chief among them *curiosity*, but also *sense of agency*, *competence*, *achievement*, *mastery*, and *goal-setting*. This is one of the most interesting findings which lends support to prior claims linking game uncertainty to curiosity, while differentiating such blanket claims with more detailed suggested mechanisms around different kinds of uncertainty sources.

The results position *player uncertainty* at the center of the uncertainty loop between *game uncertainty* and *outcome uncertainty*. This is given that the player's first exposure to a game would be the game's content itself and thus *game uncertainty* and the final communication would be an outcome and thus *outcome uncertainty.* This feeds into player's uncertainty regarding interaction, decision making and adaptation feeding into their uncertainty of outcome. Since the most central role over here is of the player, the action the player takes, keeps the system running. In that action, we deduce that the choices the player makes is of utmost importance. In agreement with the established role of choices and decisions in games, we consider *decision uncertainty* at the very center of the m2m movement of gameplay.

Limitations and Future Work

The present study has been intentionally limited to pick-n-play games, suggesting expansion and replication for other game types. Our participants were reasonably diverse, this can always be improved upon. As a qualitative study following grounded theory, we can claim qualitative validity and reliability in that we made our data collection and analysis processes transparent and followed principles of constant comparison and theoretical sampling. But the presented findings are obviously not statistically reliable, suggesting follow-on quantitative work. We have presented motivational links (esp. with *curiosity*, *mastery*, *achievement* and *competence*) at a level of granular analysis that calls for future work exploring other player experiences like *challenge* (Adams, 2014; Schell, 2014) and how uncertainty breakdowns and breakthroughs (Iacovides et al., 2015, 2011) are interwoven at a micro level gameplay. That said, we believe that the presented taxonomy of game uncertainty enriches our current understanding especially from the perspective of m2m engagement, and puts it on a more reliable footing of

systematic naturalistic observation.

Since, we have discovered that these seven uncertainty types can play a key role in making a motivating play loop for the players, we are thoroughly interested in investigating what are the different methods in which uncertainty (each type) can be induced in gameplay. We believe this would be a useful direction of investigation for game researchers, game developers and the players.

This study addresses the questions around the role of uncertainty in m2m player motivation. Our related research question is now that we understand uncertainty at a granular level a bit more, how can we elicit such uncertainty in players so that they feel motivated to continue. We take on this task of finding new techniques to create *decision uncertainty* where players feel free to make a choice and feel their choices have impact on the outcome for them to feel motivated to make the decision. Eliciting such uncertainty has the special challenge of creating an illusion of depth in choices when the game world is in-fact scripted. For this reason we look at the field of stage magic where magicians use a number of principles and tools to create illusory choices while the magic act is pre-scripted. We take a look at this field from the wider lens of epistemic emotions of acquiring knowledge and feelings of dealing with knowledge gaps to not miss information on how magicians must create uncertainty and *decision uncertainty* even beyond illusory choices.

Chapter 5

Stage Magic as Design Inspiration for Evoking Uncertainty[3]

Looking Beyond Games for Design Inspiration

Game developers can fall into the trap of focusing their efforts solely on analysing video games to foster their game design skills (Schell, 2014). Thankfully, there is a lot of talk around breaking this habit in order to stop the market being crammed with 'clones' (Schell, 2014). Game designers interested in breaking the status quo make no secret of the fact that they regularly 'learn' (M. Stout, 2015) (or rather, 'plunder' (W. Wright, 2001)) from other media to inform the 'total art work' of games. Jesse Schell in his book, *The Art of Game Design* persuades game designers to draw inspirations from 'everywhere' (Schell, 2014). He argues that design is ubiquitous and the hard work of studying it has already been done in other fields for a far longer period. He supports his argument by listing examples from music, architecture, film, painting, literature and a variety of other fields throughout the book making their connections with games obvious. In *Steal Like an Artist*, Kleon echoes this sentiment for any form of art, where he says, "Be curious about the world in which you live. Look things up. Chase down every reference (Kleon, 2012). Go deeper than anybody else - that's how you'll get ahead." *Monument Valley* (Ustwo Games, 2014), is a beautiful video game example of drawing inspirations from other fields. In this game the player manipulates mazes of optical illusions inspired by the drawings of M. C. Escher (Schattschneider, 1990) as reported by the developers (Games, 2014) to reach various platforms. The game space is further inspired by Japanese gardens and architectures from North Africa, India, and Islamic structures.

[3] The survey described in this chapter is also a published work (Kumari et al., 2018)

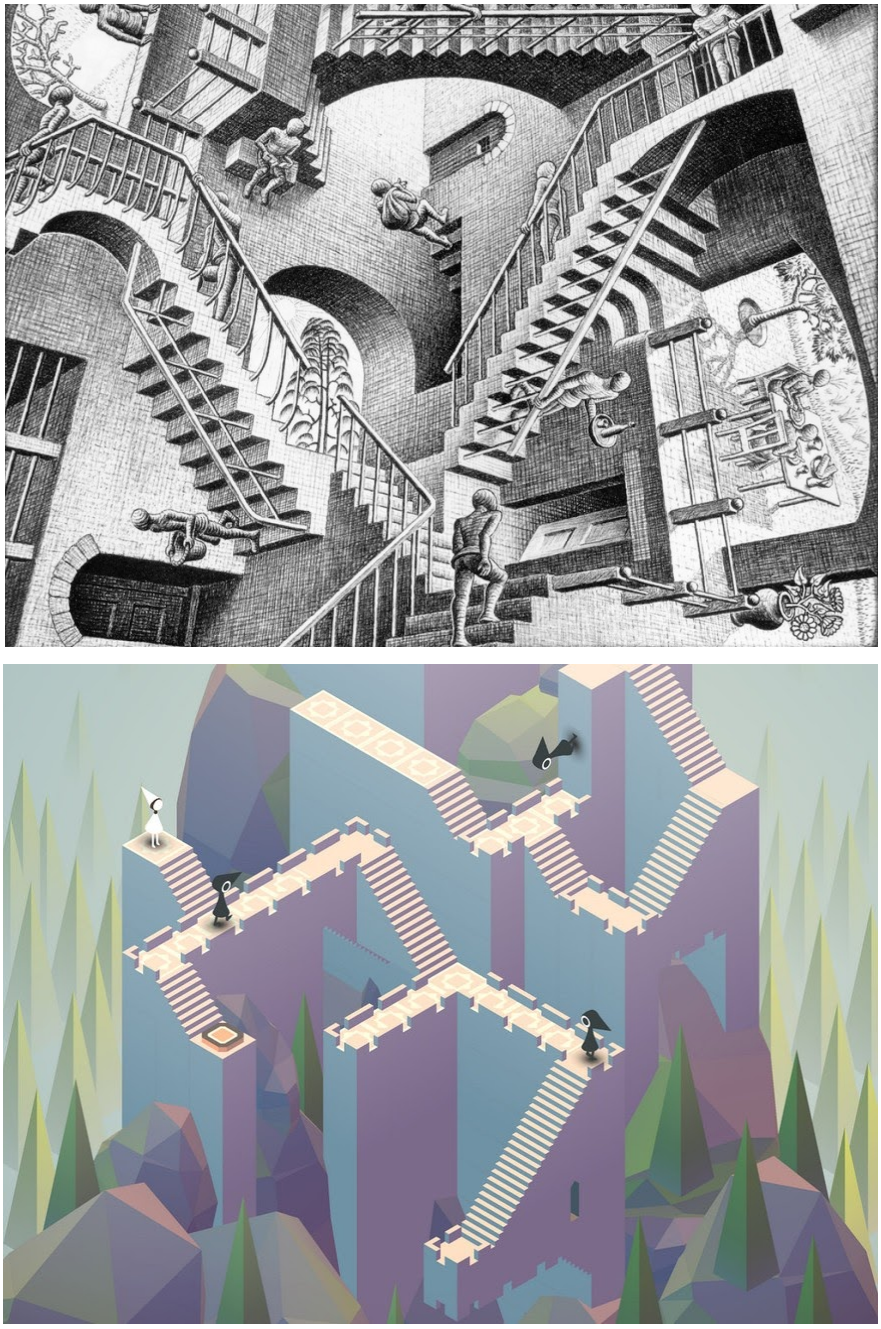

Fig. 3. (a) Multiple viewpoints and impossible stairs: Relativity, 1953 (Escher, 2000). **(b)** A level from Monument Valley

This much needed dialogue through text, talks and games has pushed the boundaries of where game developers look for inspiration. The 'non-game design book' *Understanding Comics* (McCloud, 1993) has come up as one of the most recommended books amongst game designers and students of game development. However, we still have a lot of ground to cover in terms of testing these inspirations independently with respect to specific player experiences and emotions. The complexity of game design and the expanse of fields we must forage for insight is aptly captured by Robin Hunicke, “Game

mechanics are religion. They are physics. They are biology" (Kickstarter, 2015). Our research attempts to isolate specific design inspirations from the field of stage magic and test their impact on epistemic emotions specifically that of decision making uncertainty that players are motivated to resolve.

Understandably, we can not go into all of the fields, but in our research we have found a remarkable amount of overlap with stage magic in terms of eliciting epistemic emotions through choreography of a stage magic trick to create illusory choices. As said above, these techniques are not unique to magic and we have to position this research as an entry point to utilising creative information from one of the many art fields (stage magic) to game design. This chapter is a survey of the field of stage magic. In the next sections we discuss how the lens of stage magic can give useful insights applicable to game design. It exposes relevant bits for game designers, especially with emphasis on eliciting epistemic emotions. From the literature we know epistemic emotions fuel each other. For this first survey we decompress the field focusing on how magicians design to elicit epistemic emotions to scour techniques that could kindle motivating uncertainty.

We illustrate parallels to demonstrate why exactly is stage magic a relevant field to take inspiration from. We lay out the theory of how magicians create drama by balancing emotions of curiosity, uncertainty and anticipation. We exemplify how magicians create the epistemic emotion of surprise and accompanying outcome uncertainty by violating expectations in their choreography. Lastly, we bring the focus on the principle of forcing. We discuss design techniques forcing offers that magicians use to create choice facades that make their audience make decisions when the outcomes are actually pre-determined. Transferring forcing technique to games, we suggest, would help elicit motivating *decision uncertainty* (as described in the previous chapter) in games.

Why Game Designers should Study Stage Magic

For millennia, magicians have designed illusions that are perceived as real regardless of their impossibility, inducing a sense of wonder in their audience. We argue that video game designers face the same design challenge - *crafting believable and engaging illusions* - and that the practice of stage magic provides an untapped wealth of design principles and techniques for game designers. Science fiction author Arthur C. Clarke famously observed that any sufficiently advanced technology is indistinguishable from magic (Clarke, 1973). This quote captures a key commonality of games and magic:

both aim to provide entertainment such that the audience don't see through the 'user illusion' into the 'gears' underneath (Murthy, 2002).

Through its history, magicians have honed the art of creating and sustaining engaging illusions, tested and refined techniques that allow people to "experience the impossible" (Rensink & Kuhn, 2015). Magicians have not only probed some of the most fundamental psychological questions, like consciousness or agency, but also readily adopted psychological insight into their practice (Kuhn & Land, 2006; Kuhn & Teszka, 2018; Rensink & Kuhn, 2015; Thomas et al., 2018). Game development and research is on a similar journey of learning from psychology and applying to practise (Koster, 2013).

According to Eugene Subbotsky, one of the preeminent scholars of 'magical thinking' (Zusne & Jones, 2014), any perceived breach of the laws of physical reality constitutes magic (Subbotsky, 2010a). In this respect, games are repeat offenders: cards talk (*Hearthstone* (B. Entertainment, 2014)), rules of physical space don't always apply (*Monument Valley* (Ustwo Games, 2014)), worms battle and bad-mouth each other (*Worms* (Team17, 1995)), and plants defend their territory against waves of invading zombies (*Plants vs Zombies* (PopCap Games, 2009)). Not only are games often set in fantastical worlds full of such magic, game designers like magicians strive to create an engaging experience for their audience - adapting, testing and refining insights from fields like psychology (VandenBerghe, 2016) to find better ways to foster engagement (Przybylski et al., 2010), create surprise (Schell, 2014)}, afford a sense of autonomy and agency (Ryan et al., 2006), etc.

More than two decades ago, Bruce Tognazzini (Tognazzini, 1993) made a case for applying stage magic principles to human-computer interaction (HCI). He observed an "eerie correspondence" between the two fields and encouraged a broad array of researchers and designers to probe and use ideas and techniques from magic in interaction design (Boll et al., 2008; Marshall et al., 2010; Rasmussen, 2013; Reeves et al., 2005). Arguably, if principles from magic can be used to improve interaction design and HCI research, game design and research should stand to benefit even more. Both games and HCI try to provide seamless and meaningful user interactions (Jorgensen, 2004), and game design by some accounts is the 'true' embodiment of experience or entertainment-centric interaction design (Blythe et al., 2006; J. M. Carroll & Thomas, 1988; Hassenzahl, 2010). The underlying concepts are not exclusive to magic, however, magic shares uncanny similarities with games - they both revolve around the same core experiential qualities, like engagement (Przybylski et al., 2010), immersion (Cairns et al., 2014), or escapist fantasy (Yee, 2006), making magic a unique lens to study the underlying principles.

Magic has been proposed as a game design source (Games Now, 2016) and game designers like Will Wright frequently cite magic as their inspiration (Donlan, 2015; Mullich, 2016; M. Stout, 2015; W. Wright, 2001). In a GDC session, *Good Game Design is like a Magic Trick*, Jennifer Scheurle reveals 'hidden' techniques that game developers have used for decades to create compelling gameplay (Scheurle, 2018). She presents data coalesced from a number of game developers of a variety of games. Her talk lists examples where the designers have *tricked* the players by not giving them complete information. For instance, she discusses 'coyote time' which is an invisible feature implemented in most fast paced side view platformers: the player is given a small window in which they can make a jump even if they are slightly off the ledge (see Fig. 4). Scheurle explains how these illusory tricks are not cheats but an integral part of game design toolkit for crafting seamless experiences. Teller shares the same sentiment for magic, "Magic is an art form where you lie and tell people you are lying" (Teller, n.d., 2019) but this doesn't necessarily spoil the felt experience of the magic audience or the player. Fiction writer, Christopher Priest who penned *The Prestige*, eloquently sums it, "The magician takes the ordinary something and makes it do something extraordinary. Now you're looking for the secret… but you won't find it, because of course you're not really looking. You don't really want to know. You want to be fooled (Priest, 2006)." Scheurle discusses such trade secrets or trickery of game design and the willingness of the player to be fooled. While she discusses glimpses of magic in games, she doesn't delve deeply into magic principles or provides concrete information about what can be brought to games from the field of magic.

Fig. 4. Coyote Time: the player is able to take off in a jump even if there is no platform below. *Rayman* (Ubisoft, 1995).

Although game designers are interested in magic for inspiration, very little has been worked out more rigorously about the structural parallels between stage magic and game design, and how stage magic might inform game design practice. With our work we take a starting step towards filling this gap, especially with regards to what stage magic can teach us about motivating

uncertainty i.e. uncertainty that players are motivated to resolve with gameplay. We make no claim of providing a systematic let alone comprehensive survey of the intersections between games and stage magic. Rather, we want to make the case for applying stage magic to game design by demonstrating how fundamental concerns of stage magic mirror those of game design and how related techniques could be transferred today, especially to elicit motivating uncertainty and related epistemic emotions.

Stage Magic as an Effective Lens for Studying Epistemic Emotions

Ghosts, witchcraft, astrology, magic etc. have been connected with epistemic emotions (Jahoda, 1969; Zusne & Jones, 2014). These emotions of curiosity, interest, uncertainty and surprise (Pekrun & Linnenbrink-Garcia, 2014) are known to be linked to each other and are reported to play an essential role in the field of magic (Vidler & Levine, 1981).

One of the major takeaways of our investigation into uncertainty in games reports on *when* and *why* uncertainty becomes motivating connecting it to many known motives, especially curiosity (see Chapter 4). The connection between magic and curiosity is well established in literature (Vidler & Levine, 1981). Curiosity towards the unknown is one of the key motivators for the magic audience as they are inquisitive about the progress of a magic trick and the secret behind it (Ortiz, 1995). Subbotsky claims that novel and unusual events elicit stronger curiosity and exploratory behaviour if its suggested explanation involves an element of magic (Subbotsky, 2010b). Moreover, Ozono et. al. suggest magic tricks as an obvious medium to study epistemic emotions (Ozono et al., 2020). They say that magic tricks have a unique aspect, that is they induce a strong sense of violation of expectation making spectators naturally motivated to solve their curiosity, thus likely to induce relatively strong feelings of epistemic emotions including uncertainty (Danek et al., 2015; Ozono et al., 2020; Pekrun et al., 2017; van Lieshout et al., 2018).

The magic audience experiences wonder because they erroneously attribute a magical cause, rather than the true cause (the secret method), to what they have just seen (Kuhn, 2019). Surprise is caused by the discrepancy between expected and actual outcomes, and this discrepancy triggers them to progress and make future decisions (Dole & Sinatra, 1998; Rescorla, 1972). Magic depends on the stimulation of interest through the creation of surprise and conceptual conflict (Vidler & Levine, 1981). The constructs of uncertainty, surprise, anticipation, tension, curiosity, interest, suspense, wonder seem to

be thoroughly connected and almost interchangeably used in popular text in the field of magic. There is an established link between these constructs and the illusions and impossibility afforded by magic (Ortiz, 1995; Ozono et al., 2020; Vidler & Levine, 1981). From Chapter 3 and 4, it is clear that important m2m player experience constructs like uncertainty, curiosity and surprise are also tightly linked. They continuously inform one another for a rich and propelling player experience. The field of magic offers an apt lens for design insights to elicit these experiences and motivations in players as these are exactly the kind of experiences that magicians have known to be successfully eliciting in their audience. From our study of the text in the field of stage magic, it is apparent that to get insight about uncertainty we must look broadly into the relation of stage magic with all these related constructs.

Dramatics of Suspense and Surprise

In his popular book, *Strong Magic,* Darwin Ortiz analyzes and deconstructs magic acts from across a variety of magician's works. He clubs epistemic emotions as essential part of the audience's experience. He singles out *surprise* and *suspense* as the two most powerful dramatic tools that magicians use. Both of these tools play with audience expectations that create continued interest and engagement in the magic performance (Ortiz, 1995, pp. 182–217).

Violations of causality and expectations are at the heart of magic performances (Kuhn et al., 2008; Kuhn & Land, 2006). To induce surprise Ortiz recommends establishing a pattern and then breaking it in a twist ending or unexpectedly adding a second/kicker ending (Ortiz, 1995, pp. 182–217) after the first anticipated ending. The audience tries to understand the real causal sequence of events (Kelly, 1980) and a causality violation is a surprising event (Parris et al., 2009).

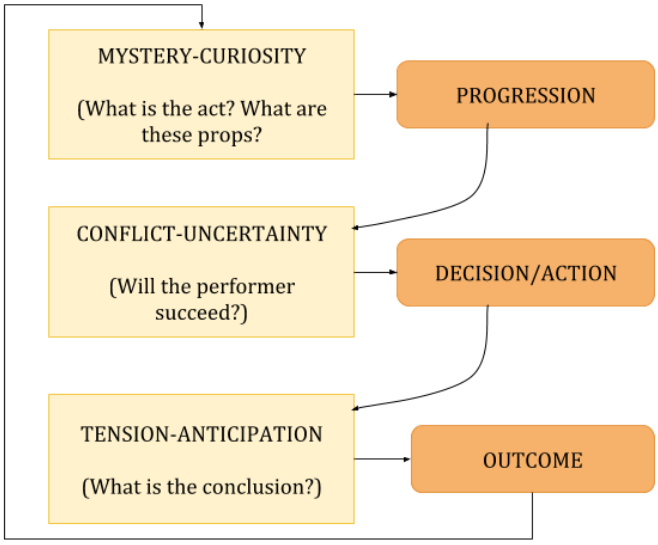

Fig. 5. Ortiz's 3 steps for building effective suspense in a magic trick

Oritz outlines 3 steps to unravel a trick up for engaging suspense. *Mystery* (magical set up) evokes *curiosity*, then *conflict* (whether the performer will succeed or not) creates *uncertainty* and finally *tension* (wait for the conclusion) creates *anticipation.* He explains that curiosity is resolved by explanation or progressing in the trick; uncertainty is resolved by decision; and anticipation is resolved by fulfillment (see Fig. 5). This loop is not too different from the game loop we discussed in the previous chapter - the game's *mystery* (set up) makes players curious about new game content (*game uncertainty*) which is resolved by progressing and encountering new items. They are then locked into the *conflict* creating uncertainty regarding their performance (*player uncertainty*) resolved by their decisions and actions. Finally followed by *tension* and *anticipation* of what the outcome of their actions would be (*outcome uncertainty*) resolved by knowing the results.

Oritz clearly states that an effective way to create *mystery-curiosity* is by adding new props (mapping with new game items of *game uncertainty*) that pique the audience's curiosity. He suggests magicians hide *features* and release them slowly to upkeep the curiosity: resolving a mystery by introducing a bigger mystery. A break in the patterns established in cascading this mystery creates desirable surprise. He proposes that an unanswered question keeps the audience engaged till the end. A lot of his suggestions converge around having new unexpected content or creating causal relations that can be violated without breaking the logic of the trick. This directly maps with *game uncertainty* (see Chapter 4): the novelty of new content maps with

content uncertainty pillar of *game uncertainty* and the creation of new unexpected patterns maps with *configuration uncertainty.*

Conflict-uncertainty, the second step after making the audience curious about the setup, is basically risen from any task that is risky. The performer can potentially fail either because of skill or chance. The uncertainty of success keeps the audience hooked to the performance. This maps with *player uncertainty* regarding their own performance in a game (see Chapter 4). He calls this the *Failure Effect* where the main curiosity/uncertainty arises from whether the performer will be able to 'overcome the problem'. Ortiz emphasises that all that matters is the audience perception of this uncertainty to keep them engaged. He uses the example of card forces and predictions to illustrate this point where the audience participates and understands the choices and thus the odds of reaching the desired conclusion or prediction. Overcoming this uncertainty is key to keeping the audience motivated to follow the magic trick, hoping for a fulfilling conclusion.

Lastly, *tension-anticipation* is the third important step where the audience is expecting a satisfying conclusion. Just like *outcome uncertainty* in games, this is where the conflict ("can the performer solve the problem?") is hopefully answered. The tension that creates anticipation in the audience is resolved by the outcome itself. Ortiz warns magicians that there is a sweet spot of how much to make the audience wait for the conclusion, too much of it can make them feel manipulated. This neatly maps with our finding about calibration of *result uncertainty* (see Chapter 4).

To evoke suitable curiosity, uncertainty and anticipation Oritz points out that the audience must feel a sense of progression. They should feel that every loop is more interesting and the most fundamental way of doing it is by increasing the difficulty. He explains that interesting progression can be created by holding back features and releasing them after building uncertainty. Other methods are by increasing the stakes, making the conflict of *failure effect* rise or by increasing the speed or tempo. These methods of building progression reminds us of mastery in games which is another motivation linked with motivating *player uncertainty* (see Chapter 4).

The above literature provides us with plenty of motivation to look into magic to find techniques to evoke motivating uncertainty in games. As can be seen, uncertainty for curiosity is core to magic and games, and magicians have analysed its workings in detail. It gives us unique insight into how game designers can invoke uncertainty, curiosity and surprise in players. To support this further, we take a deep look into magic from the design

perspective of how an act is set up to create surprise and illusion of choice. We focus on these two aspects as we believe that these are closely linked to the creation of motivating uncertainty (see Chapter 4). We explore two key principles of stage magic: violating perceived causal relations and forcing perceived-free choice. We present techniques to create and exploit these effects and discuss their parallels and applications in game design, encouraging game designers and researchers to further explore the field of magic for testable theories and applicable techniques. For each, we explain the principle and then work through a number of techniques game designers could import.

Convincing Causal Set Up For The Dramatic Loop

Immersion and presence are widely valued and studied experiential qualities of gameplay (Cairns et al., 2014; Schuemie et al., 2001). Both require the maintenance of a fundamental illusion present researchers have called "non-mediation" (Schuemie et al., 2001). As any other work of fiction, games present a diegetic world that is entirely unreal: every interaction via the graphic interface of a game is an illusion. Players endorse the belief that they are directly manipulating objects on screen through some external control unit while in reality they are interacting with the game code which in turn interacts with the computer's processor to carry out the action. Unless by intention, this is not the experience game designers want the players to have. They devalue moments when this illusion of non-mediation is disrupted through glitches, lag, or unresponsive controls etc. and instead want players to stay in the magical reality of the game world (Nitsche, 2008).

One of the main aims of a magician's deception, is just that: to make the spectator's illusion more and more 'real'. Games must do this to make players understand the world and start creating expectations. “If I do *this,* I expect *this* to follow.” Such expectation sets up the stage for future manipulation of the world to elicit surprise. It also makes the magic audience curious about what the act is and what the props must be for. In games, it would allow for the player to tinker within the rules and kickstart the motivating uncertainty loop, “What are these game items? What happens when I interact with them? I expect it to react in such a way, does it?”

To strengthen the reality of a make-belief world, the magician Derren Brown recently designed a *Ghost Train* (Manthorpe, 2017) in one of the UK's leading amusement parks which tries to scare people with unreal objects and events, both represented via virtual reality (VR) and holograms. In many VR gaming experiences, players remain aware of the VR headset, diminishing the sense

of presence. *Ghost Train* overcomes this issue by asking players to wear a gas mask (a disguised VR headset) to protect them from poison gas released into the train. This narrative frame accounts for the existence of the headset and makes the representational device a logical part of the presented illusion. Such narrative framing is a common principle used in stage magic and offers a nice demonstration of how stage magic techniques can be implemented in a game environment to help enhance the user's illusion.

More principally, a successful magic illusion generates the experience in the audience that an impossible cause was behind an observed effect. This generates the mystery discussed earlier on. For instance, in one of his more famous illusions, the magician Robert-Houdin seemingly grew oranges on a barren tree by raising his hand (Robert-Houdin, 1859). Houdin tried to convince the audience that he possessed gestures of magical power that *caused* the oranges to appear within seconds. The underlying psychological principle leading the audience to 'buy into' the illusory cause to an observed effect is called perceptual causality (Scholl & Tremoulet, 2000): for certain kinds of sensory experience, we have the tendency to directly and automatically perceive or experience a causal relation. Experimental data supports that people during magic tricks experience the perceived cause-effect relation as real *although they are aware* that it defies their knowledge of the world (Parris et al., 2009). Sceptics like Hume (Hume, 2003) caution against assuming a causal relation between B and A simply because we observe a pattern of B following A. Courses in logic or research methods repeat the mantra that correlation does not imply causation. Yet, the human mind organises the world in terms of cause and effect, deriving it from the sequence of occurring events: if B closely follows A, we perceive A to cause B (Michotte, 2017; Schlottmann & Shanks, 1992). In everyday life, this is why, people often perceive and endorse illusory causal relationships - and magic exploits this fundamental perceptual tendency.

Evidence suggests that, the more perceived causality is *coherent*, the more it contributes to the experience of presence in virtual environments (Cavazza et al., 2007). In other words, to uphold a coherent illusion, all of the elements of the game world must make sense with relation to each other. In a game, this coherence is determined by the behaviours of game objects: how they react on interaction with one another and the player's input. For example, in the game *Katamari Damacy* (Namco, 2004), the player plays as the Prince of Cosmos who is sent to Earth with orders to roll its contents into several oddly-shaped balls. Players roll a katamari ball around, and objects smaller than the ball get stuck to it, increasing its size, while objects bigger than the ball present as obstacles. The whole conceit of the game is outlandish, and yet

the game quickly makes sense to the player. It achieves this by audio-visually presenting coherent causal relations between game objects: on ‘collision' of the on-screen katamari ball with an on-screen item, the item is 'stuck' to the ball if it is of appropriate size. A magical physical reality is created: the player is repeatedly exposed to a correlation between collision, ball and item size, and sticking/non-sticking, learning to see and accept the causal interaction between them as the magical reality of the game world.

As can be seen, the mechanism of perceived causality is already at work in any interactive interface and can be used as a lens to evaluate and improve how the game world is presented to the player. At the most basic level, any perceived causal incoherence is likely to confuse the player. Furthermore, if there are several potential causes preceding one effect, this makes it harder for the player to perceive and learn the actual intended causal relation. Take *Badland* (Frogmind Games, 2013), an action adventure game where the player flies around as a little creature navigating a number of traps, puzzles and obstacles in the woods. The player has to avoid environmental obstacles to survive. Now, if the player's avatar simultaneously collides with a gear (obstacle) and a spike (obstacle) and dies, the player doesn't know which item caused the death and is to be avoided: the spike, the gear, or both. It would therefore be advisable to introduce these causal relationships separately as part of the on-boarding process to facilitate the player's learning. The more the game's causal laws deviate from our lived reality, the more important it becomes to explicitly introduce them. The interaction of objects in the game world itself can 'teach' them instead of artificial tutorials. Where game designers talk about tutorials, on-boarding, or learning the game, they often exclusively focus on learning how to master the controls, how to win, or how to play strategically well (M. M. White, 2014), when indeed players in most games have to learn a more fundamental dimension of the game as well: the causal laws of its magical reality. Evidence from psychologists studying magic suggests that causal relationships that are in line with our prior beliefs are endorsed more readily than others. In one study, participants were asked to place their driving license into a box and suggested that a magic spell will be cast that removes the stamp on the license. Very few participants entertained the possibility that the stamp could be removed by magic. However, when the suggested cause was changed from magic to a physical device, many more participants accepted its possibility (Subbotsky, 2011). This suggests that even within illusory causal relations, one must understand the boundaries of what the audience is ready to endorse.

Violating Established Causality to Create Suspense and Surprise

Magicians use the principle of perceptual causality not just to create illusory causation, but also to surprise the audience by violating existing causal expectations or establishing then breaking new ones. Take for instance a standard routine where a magician visibly puts a coin in his right hand, then waves his left hand over his right hand, followed by slowly opening his right hand to reveal that the coin has disappeared. This chain of events produces surprise, as it violates several causal relationships the audience have learned through past experience (Parris et al., 2009). This constantly suspenseful and surprising play with setting up and violating (causal) expectations sits at the heart of magic performances and their appeal (Kuhn et al., 2008). Surprise is also elementary to game enjoyment - as Jesse Schell puts it, "fun is pleasure with surprises" (Schell, 2014). More systematically, Greg Costikyan argues that games hold players' interest through various forms of uncertainty that generate suspense (how will they be resolved in the future?) and surprise upon unexpected resolutions (Costikyan, 2013).

So how do magicians design their performances to create timely surprises? The basic technique is to first establish and reinforce a cause and effect pattern through demonstration and then break it. For instance, in one routine by the magician duo Penn and Teller (Penn Jillette, 2015), Teller hands a fish bowl to an invited volunteer on stage. On Teller's left-hand side stands a fish tank filled with water. On his right side, the volunteer is seated with an empty fishbowl in their hands. Teller washes his hands in the water-filled fish tank on the left. Rubbing his hands in the water, he seemingly produces a coin from nowhere in his hands, throwing it into the empty fishbowl held by the volunteer. Teller continues to produce coins from his hands, establishing the pattern that his hands are producing coins. Teller doesn't stop there though. Once people start becoming familiar with this pattern, he twists the variables by shaking the participant's necklace and glasses and his own tie to produce more coins from each. Doing so, he extends the domain space of what objects can produce coins, both building upon and gently violating the previously set expectation. He ends the show by collecting all coins and blowing on them, thereby converting them into fishes in the fish tank. Once the audience have come to expect the magical reality of coin production, this expectation is again built upon and broken - coins can now both be produced out of nothing and transformed into other objects. The overall experiential sequence is captivating and surprising at every turn.

If we take a step back, we can here see a more general pattern of gradual reveal of the causal laws of an illusion that is at once educational, suspenseful, and surprising: establish, then break and extend. We can again see immediate parallels with how games introduce mechanics. Take *Bejeweled* (PopCap Games, 2001), a tile matching game where players swap one gem with another adjacent gem to form a horizontal or vertical line of three or more matching gems of the same color. The player is first taught that creating matches makes the gems disappear. Once the player has learned to expect that relation, they are presented with matches that change the board, creating a subtle surprise while expanding the player's knowledge of the game's rules. Next, the player finds that the board can also affect the gems by locking them, etc. As this example shows, it is not as if this kind of scaffolding is absent in games. But within frameworks like rational level design, game designers discuss and design it chiefly in terms of difficulty balancing or challenge (McEntee, 2012; M. M. White, 2014), but not with a view of using the causality of the game world for introducing it or creating enjoyable surprises in its discovery. 'Open world' or 'sandbox games offer an obvious case in point where this delight in exploring and discovering weird, new, unexpected, surprising possibilities of a magical reality is front and center (Yee, 2016). Here and in other game genres, stage magic can give us a template for orchestrating or sequencing the reveal of the game world to interleave suspenseful uncertainty and delightful surprise, much like Teller does in his act.

Setting Up Puzzles For Audience to Seek Resolution

For a certain part of their audience, stage magic tricks don't just unfold a magical and surprising reality, they also present puzzles to solve: How did the magician manage to create this illusion? As the magician is performing their routine, some audience members are mentally trying out 'solutions' that would provide a possible causal explanation for the seemingly impossible cause of events they witness. In games, this ties into the *player uncertainty* of performance that comes with problem solving leading to uncertainty regarding the outcome. Costikyan's terminology for this is *solver's uncertainty* (Costikyan, 2013).

To maintain the illusion (and keep puzzle-solving audience members intrigued), magicians need to constantly think one step ahead of the audience. They have to anticipate what possible explanations the audience will come up with, to then either break the resulting expectations or work with them as a way to misdirect the audience's attention. The misdirection applied would lead the audience to mentally track a plausible but false

'solution' that will result in even greater surprise if followed by events that cannot any longer be explained by it. For example, if the audience is convinced that the magician has just hidden a card up their sleeve (because the magician went through motions hinting that), the audience is likely to continue to think so and try to 'read' the remainder of the performed trick from that light, allowing the magician to do the actual relevant parts of their trick relatively unattended, e.g., keeping the card hidden in their other hand all the time, generating all the more surprise when the card 'suddenly' appears in that hand while the audience assumed it hidden in the other hand's sleeve.

Solving the puzzle of how a card disappears and reappears or how Teller manages to produce coins from nowhere is fundamentally similar to finding the combination of inputs that opens a lock in the puzzle game *The Room* (Fireproof Games, 2012). The same choreographic pattern that serves to introduce a world or allow suspense and surprise (establishing, then building on and stepping beyond causal expectations) also provides a good heuristic for designing enjoyable problem sequences, be it magic tricks or level sequences for puzzle games (Menzel, 2016). Puzzle designers need to gauge what solution strategies the player currently knows and is likely to use to create a new problem that is one step ahead but not too far, depending on the designer's intent. Again, the principle is to introduce a pattern and then break and extend it the very instant the player both begins to expect the pattern and can 'see' and digest a deviation. Popular puzzle games like *Monument Valley* (Ustwo Games, 2014), *Angry Birds* (Rovio Entertainment, 2009), *Portal* (Valve Corporation, 2007), *The Room* (Fireproof Games, 2012), or *Limbo* (Playdead, 2010) demonstrate this in different ways. In the puzzle platformer *Limbo* (Playdead, 2010), for instance, the player controls a boy who can move, jump, climb, and push or pull objects to pass through each level. Levels are designed so that the player would see a situation that makes them think of one learned solution - say, jumping over an opening trap door. However, the game also 'thinks one step ahead' and sets up a puzzle whose solution requires the player to realise how to deviate from and extend the prior solution, for instance, a timed jump over the trap door that would lure a chasing creature to be trapped by it. Solving the puzzle by breaking and extending a learned pattern or solution generates enjoyable surprise and a sense of increased mastery or competence (Menzel, 2016). Unlike magic, where actually knowing the solution of how a magic routine is done may make it less enjoyable, games do want the player to find the solution with varying degrees of ease as per the game's requirements. Thus, only the principles behind anticipating the audience's plausible thoughts to lay out the

problem is something designers can learn from magicians, however, balancing in a way that the problem is not impossible to solve.

If game designers want to predict and steer players' thinking the way a magician sets up 'solutions' in their audience's heads, the question arises how to ensure a player or audience member is thinking of one particular 'starting' solution rather than any other. If players start from a 'wrong' solution (e.g. mistaking a jump-and-time puzzle for a run-and-jump puzzle), they will simply fail repeatedly without getting closer to the new, extended solution. This is something designers may find in playtesting to resolve. To ensure the audience thinks of and expects the 'right' causal pattern at the right time, magicians rely on several principles of misdirection to manipulate what people perceive and remember providing valuable insights into how best to guide the player's thinking processes towards the goal. For instance, when a magician throws a ball in the air several times and then the ball 'vanishes', the majority of the audience perceive and remember the ball to leave the magician's hand, move upwards, and disappear, even though the ball did not leave the magician's hand (Kuhn & Land, 2006). The magician first establishes a familiar causal pattern (throwing things high in the air) and then provides visual cues (a rapid upward hand movement) that recall that pattern, making the audience think of and assume it to be the actual causal pattern (Kuhn & Rensink, 2016).

Magicians also rely on the *Einstellung effect* (from the German word "Einstellung", literally "setting" or "installation") (Luchins, 1942). This describes the well-validated effect that when people have learned a solution to a given problem, they are likely to think of and stick to this solution when presented with a new situation that shares familiar features of the first problem, even if the solution doesn't work or better solutions exist. For example, studies by Thomas and colleagues (2018) have shown that when participants were primed with a false solution to a magic trick (e.g. that the magician palmed a card in his hand), this false solution prevented them from discovering the true solution to the trick even though they knew that this solution was impossible. This effect is just as relevant to designers of puzzles and other games, as it can get players stuck or be used to 'signpost' solution routes. In the guessing game *Codenames* (Vlaada Chvátil, 2015), for instance, two competing teams need to guess the right set of 25 'code' words laid out in front of them. Each team has a "Spymaster" who gives one-word clues pointing to multiple words at once. Once a guesser is convinced of one interpretation of the Spymaster's hint, it is hard for them to think of other interpretations. This plays out delightfully in the game's social setup as vibrant discussions among guessing team members. However, if *Codenames*

were a single player game, the guesser could easily get stuck on their idea and thus be frustrated by repeatedly making wrong guesses. Similarly, if a puzzle game like *Limbo* (Playdead, 2010) wants to avoid players getting stuck on wrong solution paths, it would do well to time it and use audio-visual cues that recall the earlier situation in which the first part of the correct solution path was established and learned.

Creating the Illusion of Choice

In the previous chapter we see that players feel *decision uncertainty* when they feel they have a free choice and that their choice will have an impact on the outcome. Choice is fundamental to gameplay and gameplay enjoyment. Sid Meier famously says that, "Games are a series of interesting decisions" (Meier, 2012). According to self-determination theory (SDT), autonomy, the experience of acting self-determinedly, with volition, willingness, and in congruence with one's own goals, values, and identity, is a basic psychological need whose satisfaction makes an activity intrinsically motivating and enjoyable (Ryan & Deci, 2017). And while 'having choice' as such does not equate autonomy, an open environment or situation that affords many different options contributes to the experience of autonomy (Ryan & Deci, 2017). In the last decade, numerous researchers have tested self-determination theory to explain gameplay enjoyment, e.g. through the measurement of Player Experience of Need Satisfaction (PENS) (Peng et al., 2012; Reinecke et al., 2012; R. M. Ryan et al., 2006). Numerous empirical studies support that SDT in general and autonomy experiences in specific can explain significant portions of gaming motivation and enjoyment (see (Ryan & Deci, 2017) for a general review and (Deterding, 2016) for a review regarding autonomy). Games support autonomy by giving players a high degree of choice in who they want to embody, how they want to appear, and what goals, strategies, and activities they want to pursue (Rigby & Ryan, 2011). A good example is *Minecraft* (Mojang, 2011), where the player can freely choose what to do or build in an open world (VandenBerghe, 2016).

Sense of Agency

Sense of agency in players is a closely related topic where the term ‘sense of agency’ refers to the feeling of being in control of one’s actions and consequently the connecting external events (Chambon et al., 2014; Vilaza et al., 2014). It is the subjective feeling that one is the author of their own actions and the outcome of those actions (Dewey & Knoblich, 2014; Gallagher, 2000; Haggard & Chambon, 2012; Haggard & Tsakiris, 2009). This also refers to the sense of having control over the changes one's actions make

in the environment (Barlas, 2016). In line with research in psychology (Karsh & Eitam, 2015; Penton et al., 2018) which suggests that actions associated with a high sense of agency are intrinsically rewarding and thus motivating, Schott (Schott, 2006) and Murray (Murray, 2017) place agency as one of the key contributors to engagement in games. While immersion and transformation exist in non-interactive fields, interactivity (via choices in games) enables the audience's sense of having agency within the story (Mateas, 2001), making them a key component in the decision of how the story would play out. For any choice to feel impactful, the player must feel a sense of agency to hold themselves responsible for the outcome (Vilaza et al., 2014). While autonomy is key to feel self determined, a sense of agency makes the players feel responsible for their choices and outcomes. Interestingly, in role-playing game narratives we start seeing imaginary agency i.e. players tend to attribute agency to characters appearing to be not under their control, and this is core to the imaginative process that brings such games to life (Parsler, 2010). The question is do players have to feel agency on their own character for such an attribution. That is, can the illusion of agency be created in the game world without any true agency at all?

Sense of agency in players has been investigated with respect to actions, choices and decision making, for example, Janet Murray describes it as "the satisfying power to take meaningful action and see the results of our decisions and choices" (Murray, 2017). Calleja looks at agency at both macro and micro levels with respect to player's need to control the immediate and long term outcome of their actions (Calleja, 2011, pp. 55–64). Similarly, Wardrip-Fruin et al. propose that 'intention' to act or make decisions is valuable immediately and in longer term, their example being, "from a quick plan to cross a river to a multi-step plan to solve a huge mystery" (Wardrip-Fruin et al., 2009). They both support that sense of agency propels people to engage with actions and related decision making in games where they must face an immediate challenge or resolve a longer problem.

Studies support that people are motivated to act over and over if they are convinced that they control (feel a sense of agency towards) the outcome (Penton et al., 2018). In line with our study results, research on sense of agency shows that people are more motivated to continue acting if they feel they can impact the outcome and feel that they did impact the previous outcomes (Penton et al., 2018). Within games and interactive design, there has been substantial amount of work especially with respect to narrative design discussing the relation between player action and narrative progression with the common goal of enabling players to feel they control the outcome (Cardona-Rivera et al., 2014; Harrell & Zhu, 2009; Mallon, 2008;

Weyhrauch & Bates, 1997). However, unlike psychology, game theory studies do not give us methods for actually measuring sense of agency.

In games, Thue et. al. (Thue et al., 2011, 2010) build upon the notion proposed by Thompson et.al. (Thompson et al., 1998) that the amount of agency one feels depends on how much they desire the outcomes that result from their decision. We start seeing the links of player choices, decisions and their impact on the outcome to be essential in making players feel in control. Subsequently, from the perspective of our research we can say that the gap between decision and outcome would be where a player would be uncertain if they are in control or not. If the outcome follows their decision, the uncertainty would be resolved with confirmatory feedback and if not then depending on the degree of uncertainty could lead to loss of sense of agency and thus demotivation. Our results show that a certain level of uncertainty is motivating for the players. Somewhat in contrast, Church (Church, 1999) emphasises on the role of simple and consistent controls for player actions, combined with predictable outcomes which make it easy for them to play and continue playing: "The key is that players know what to expect from the world and thus are made to feel in control of the situation." The role of certainty/ uncertainty becomes forefront in this analysis as he says that if players are uncertain about their action they may not intend to continue playing whereas our research shows this uncertainty itself can be motivating in terms of players wanting to resolve it and thus intending to continue playing. While sense of agency is being proposed as the high probability of players being able to predict the outcome, we found that there is a range of unpredictability/uncertainty that still makes players curious and motivated without taking away their sense of agency. As Calleja points out and we find in our study, unlike real life, players in games are not working to fully reduce uncertainty but there is a certain degree of uncertainty within which the players feel a satisfactory level of agency for the game to remain engaging and the uncertainty to be in-fact motivating (Calleja, 2011, pp. 55–64).

The above work on sense of agency shows that players need to feel in control of their decisions when posed with a choice and the outcome should be within a range of uncertainty for them to continue feeling that they were the agents of their own actions.

Providing players 'total' freedom of choice is practically impossible in digital games. Increasing player choice quickly explodes production costs, as any possible choice needs to be met with rendered game content, from the earliest text adventures to today's open world games. In addition, the more control over the flow of events is handed to the player, the less ability the

designer has to prepare and ensure a desired experience. Thus, game designers are usually faced with a trade-off between fidelity, polish, production values and authorial control on the one hand and player choice on the other: the more well-crafted the content, the less choice developers can afford to offer.

At the same time, most designers want to give their players the impression of choice. Essentially, they want players to believe that the game world is expansive and will support their free choices within the limitation of its laws, such that players experience limits as a 'natural' outcome of the world's internal logic rather than an 'artificial' limitation of technology and production budgets. For example, while playing a platform game, a player should experience that if only they could jump higher, there would be an effectively infinite sky above them, and not think or experience that they will literally bump into an 'invisible wall' where the staged scene ends.

The question is can we create illusory or imaginary choices where the player can still feel a sense of agency. There has been some work in influencing player choices to persuade players to an outcome such that they don't lose their sense of agency (Figueiredo & Paiva, 2010). According to Barlas et al. it is relatively easy to provoke an illusory sense of control over the outcome of an action (Barlas, 2016; Barlas & Obhi, 2013; Lynn et al., 2010; Tobias-Webb et al., 2017). Magicians make people experience what we call 'an apparent action causation', providing the illusion that their choices caused an outcome. This apparent causation is what gives the audience the illusion that they are controlling the result of a choice. Magicians have developed a wide range of forces providing powerful and reliable ways to create the illusory sense of agency over the outcome (Pailhès & Kuhn, 2019). For perceived autonomy and a sense of agency players need to feel that they are free to make a choice, and they are the driver of the outcome.

We look at forcing to solve this fundamental problem designers face. The challenge of offering choice to players while maintaining authorial control over story, and keeping production costs in check. We suspect that techniques like forcing can provide the illusion of choice while nudging the player in the desired direction to control the game's unfolding.

The Principle of Forcing

Magicians have been faced with essentially the same dilemma: how to give their audience the impression of free choice when in fact they stay neatly within the planned course of action e.g., steering an audience member to

'freely' draw just the *Queen of Hearts* the magician predicted they will draw. For this, magicians have developed powerful cognitive tricks to misdirect their audience's conscious experience of the world and themselves (Kuhn, 2019; Pailhès & Kuhn, 2019). Forcing is a principle central to stage magic which allows magicians to covertly influence a spectator's choice or outcome (Kuhn et al., 2008). It refers to the set of techniques magicians use to influence a person's choice without them being aware of it, and it is one of the most powerful and versatile magical tools (Annemann, 2011; Shalom et al., 2013). In recent years there has been much interest in examining these deceptive techniques (Kuhn et al., 2008; Macknik et al., 2008; Rensink & Kuhn, 2015; Thomas et al., 2015), helping us expand our knowledge about forcing. In some instances, the magician has full control over the participant's decision, while in others they simply increase the probability of the participants choosing a particular item (Pailhès & Kuhn, 2019). The latter are conjuring techniques that mostly rely on the fact that options are presented in a way that makes one of them easier to choose (physically or mentally)(Pailhès & Kuhn, 2019). *Forcing* is categorically different from other forms of social persuasion, such as a salesperson overtly persuading the client to buy their product. In the magician's force, choices are systematically biased and one must feel that their selection was entirely free (Kuhn, 2019). Studies suggest that people fail to introspect about these types of biases (Johansson et al., 2006; Nisbett & Wilson, 1977) and justify their choices as if they were made by their own free will. Scientific studies on forcing have revealed that people experience these forced choices as genuinely free (Pailhès & Kuhn, 2020a, 2020b).

Just like perceptual causality can help understand and improve how games introduce their magical reality, surprise players, or provide satisfying puzzles, we suggest that forcing provides inspiration for how game designers can afford a sense of autonomy, agency and choice in games without needing unlimited content. We think this is possible as previous research in magic has shown that it is possible to mislead people into thinking and feeling they controlled something when we did not (Aarts, Custers, & Wegner, 2005; Pronin, Wegner, McCarthy, & Rodriguez, 2006; Wegner, Sparrow, & Winerman, 2004). In addition, forcing provides a useful lens to assess whether a game unintentionally influences player choice in a way that harms the player experience. Pailhès & Kuhn (2019) have categorised the vast range of forcing techniques into two major categories. (1) Techniques that directly influence the spectator's choice – like restricting their choice or leading them to make a certain choice which is the typical definition. (2) Techniques which provide the spectators a genuinely free choice, but in which the outcome of the decision is manipulated (Annemann, 1940; Banachek, 2002; Jones, 1994).

In this section, we discuss both the categories through four particular forcing techniques: identical choice, stereotypical choice patterns, saliency, and equivocation. We analyse these four chosen techniques as we consider them particularly valuable in the context of video games.

Identical Choice

Many forcing techniques rely on restricting your choice by making it physically impossible to choose another item (Kuhn, 2019). One of the most basic forms of forcing relies on this: restricting choice by making it physically impossible to choose another item. For example, choosing a card from a pack of cards that has only identical cards (Annemann, 2011). We can see a ready equivalent in interactive fictions that present players with a perceived branching tree of choices that would still immediately converge on the same main story beat. This straightforward technique is however also easily uncovered the moment the audience member would draw a second card from the same deck or the player replays the game and chooses a different path. Still, for a single time play experience, this technique can be effective. A slightly modified version would maintain the same fundamental gameplay function while offering low-cost 'cosmetic' differences on top. Wherever game tutorials for instance use a very forced linear path to teach the game's mechanics, which leads a portion of players to abandon the game, they could use *Identical Choice*: if the player could early on choose between a number of incidents with slightly different theming that would still each teach the same mechanic, this would likely increase player autonomy, enjoyment, and thus retention with little extra production effort. A very interesting yet accidental implementation of *Identical Choice* force can be seen in the game *Hi Octane* (Bullfrog Productions, 1995) where players are given the choice between six different looking vehicles shown to have six different sets of stats. However, despite showing different looks and stats, under the hood, all of the vehicles were identical. The developers did not plan this deception, but shipped the game like this because of time constraints. It is reported that players never doubted the system and engaged with the idea that all vehicles were indeed unique. One could argue that showing the stats as unique could be seen as outright lying.

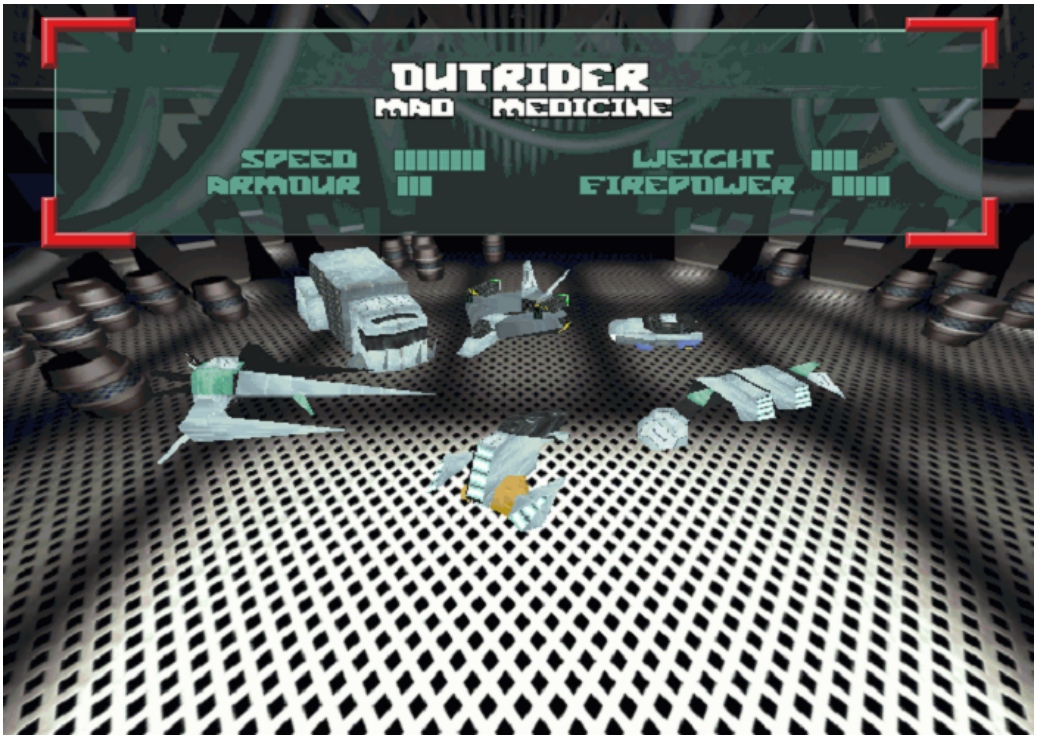

Fig. 6. Vehicle selection screen in *Hi Octane* (Bullfrog Productions, 1995) showcasing Identical Choice

There could arguably be more nuanced ways of implementing this force. For instance, in line with the game mechanics the player could be asked to choose between two boxes, however before asking them for their choice, they could be shown an animation of two different items entering each box. This setup would give them the perception that the item in each box is unique, same as how people perceive that a deck of cards by default has 52 different cards.

Restricted Choice

A craftier version of this kind of restrictive force depends on timing. For instance, in the classic force, the magician spreads the cards in a particular way and times their spreading action so that the participant's hand reaches for the intended card precisely at the right moment. Although they feel as though they had the opportunity to pick any card, they end up with the card that the magician pushed between their fingers (Pailhès & Kuhn, 2019). This can be applied to a number of dynamic decisions in a game - a simple example being a wheel of fortune. In a more complex situation, an NPC could be guiding a player about path choices as they walk and talk but the NPC stops exactly where the game wants the character to take a particular path.

Stereotypical Choice Patterns

Forcing techniques are known to exploit people's stereotypical choice patterns. For example, if the performer places four cards on the table and asks an audience member to touch one card. The right-handed audience is unlikely to touch the cards on the outside, and most likely to go for the one just right of center (Olson et al., 2015). Similarly, simply moving food to a less convenient location reduces the chance of it being chosen and consumed (Rozin et al., 2011). Placement force takes advantage of people preferring conveniently placed items in a handy location and asking people to physically select an item by touching it, or pushing it towards the performer (Banachek, 2009; Banachek et al., 2002), especially when the object's valence is not considered much (Christenfeld, 1995; Dayan et al., 2011; Shaw et al., 2000). For example, when people are asked to select arbitrary symbols, or toilet paper rolls from a stall, there is a general bias towards choosing items located in the middle position rather than those located at the edges (Bar-Hillel, 2015; Chae & Hoegg, 2013). It is suggested that this is because the items in the middle are mostly easier to physically or mentally reach (Bar-Hillel, 2015; Bar-Hillel et al., 2014). Rodway et. al. (Rodway et al., 2016) suggest that this centre-stage effect may be independent of physical reachability. This is especially interesting for video games where reachability is not physical. In theory, people are more likely to select objects that are easy to pick, and are unaware of this behavioural bias which conjurors often exploit to covertly manipulate the spectator's choice. Alfred Binet suggested that "there is a sort of laziness that is exploited without the person being aware of it (Binet, 1894; Triplett, 1900)". This is an important insight into the human psyche which becomes apparent and creates design inspiration when we look at examples of how other creatives have used it, for designing game spaces and user interface layouts.

Another example is that when you ask someone to choose a number between one and ten, the most common answer is seven (Pailhès & Kuhn, 2019). A recent psychological experiment on the probability of people naming different playing cards found that some cards, such as the *Ace of Hearts* and *Queen of Hearts*, are named with a significantly higher frequency than all others (Olson et al., 2012). Some of these and other choice patterns well-known in mental magic could be directly tested in games. As of yet, we know little empirically about players' in-game choice patterns and what features affect them, e.g. if players choosing quests or avatars make decisions based on sequence or other inclinations beyond their capabilities and value in the game world. Stereotypical behaviour has the obvious limitation that it is probabilistic and cannot guarantee that a particular option will always be

chosen. Thus, stereotypical choice patterns alone cannot be relied on to decrease production load. Nonetheless, it can inform designers how player choice may be biased in different ways.

Visual Saliency

Opening scene of the movie, *Now You See Me* (Leterrier, 2013) shows the protagonist asking the audience (on screen and off screen) to pick a card as he ruffles through a deck. Seven of diamonds is broadcasted on a skyscraper as a reveal of his mind reading. The audience members are shown baffled by how he could have known what they picked and taken by the grandeur of the reveal. The trick applied in this scene is called visual saliency.

Visual saliency is a well-validated principle, in which a particular option is made more perceptually prominent (Olson et al., 2015; Shalom et al., 2013). It is a popular trick where a magician asks a volunteer to mentally choose a card while the magician flips through the deck. As the magician flips through, each card can only be seen for a split second - except for the card the magician wants the participant to choose, which is shown just a little longer. A recent study found that this technique effectively directed people's card choice 98% of the time, and most participants failed to notice that their choice had been forced (Olson et al., 2015).

In many instances in games, designers want to direct players' choice and attention for a smooth experience without compromising on displaying the full extent of the content. Level designers want players to pick the right path through a jungle while feeling they made a competent, non-trivial choice in the course. In navigating game inventories and menus, interface designers want players to quickly direct attention to the option that is relevant to their current task. In scanning a game world map in an open world game, game designers want players to quickly notice relevant new points of interest without feeling 'railroaded' into choosing them. While in HCI and interface design, visual saliency is already understood to guide visual attention (Masciocchi & Still, 2013), what stage magic adds here as a consideration is the impact of unconscious visual saliency on perceived free choice. Be it choosing paths, points of interests, interface options, or other choices, visual saliency can be used to highlight certain choices by subtle scaling or lighting in the game scenes without impeding the player’s perceived free choice and competence.

Priming

In his popular TV show *Mind Control* (D. Brown, 2007), the mentalist Derren Brown once invited a volunteer to freely browse a toy store and in their mind choose one of nearly quarter of a million toys without telling him. It was seemingly impossible for Brown to know what toy they would pick - and yet, he correctly predicted their choice of a giraffe (D. Brown, 2014). In the program, Brown states that he used a range of subconscious priming techniques to subtly direct their mind towards the giraffe toy, e.g. making a giraffe symbol with his hands while giving directions. Yet, the volunteer had no clue that they have been primed and considered their decision a free choice. It is important to note that Brown's claim of being able to manipulate choice using scientific principles is unsupported. Magicians often frame their performances as a demonstration of psychological mind control, when in reality other forms of deception are used to create psychological mind control (Lan et al., 2018). However, this should not distract from the fact that subtle psychological principles can be used to force a person's choice.

Pailhès shows that naturally integrating primes within a person's speech and gestures can influence people's decision making (Pailhès & Kuhn, 2020a, 2020b). Her work confirms that it works both on video and in person. She primed the audience to choose three of diamonds by making corresponding shapes as she presented the trick to the audience. The force resulted in a nine-fold increased chance of participants choosing the forced item, reportedly feeling free choice and control over their actions. This work has been repeated to answer the substantial skepticism around priming.

Results and practical usages like these raise the possibility of games using this type of mind control to influence player's decisions. Just like visual saliency, priming opens doors for nudging players into the right direction. Signs in the game backgrounds, language and gestures made by NPCs can possibly mimic priming within game worlds.

Equivocation

Equivoque (Goldstein, 1996) or 'the magician's choice', is one of the strongest tools mentalists can use to force a card or item (Banachek, 2009, p. 22). It is an interesting forcing principle, where magicians give a genuine free choice to the audience but devise the next steps of the trick in a way that any choice leads to the same result. For instance, they might place two cards on the table and ask an audience member to choose one. If they choose the intended card, the magician asks them to keep the card. If they choose the other card, the magician asks them to discard it and keep the intended card. This ensures

that the used card is always the one the magician intended while the audience member had actual free choice because how this choice is then interpreted and used is determined on the fly to align it with the magician's intention. A simple example application for this in a game could be playful choices between mystery boxes (or any choice based system where the outcomes are fairly balanced). If due to content limitation or story continuation, the game has only one outcome to offer between the two boxes. The player's choice could be opened or destroyed, making the intended box the outcome. Hiroki Ozono presented an experiment amongst an audience at a magic conference in which participants watched a short video clip in which *equivoque* was used to force one of four cards, after which the participants were required to work out the method behind the trick (Ozono, 2017) . The results showed that even at a conference where people were discussing magic principles, only 12 percent of the participants managed to work out the correct solution to this force. This demonstrates the strength of a force like equivocation. Forces where the outcome is manipulated are closely related to choice blindness (Hall & Johansson, 2008; Johansson et al., 2006), a phenomenon in which people fail to notice the mismatch between their choice and its outcome. They often end up justifying their choice based on the outcome disclosed to them (Hall et al., 2013; Hall & Johansson, 2008; Rieznik et al., 2017). There is some debate around how this phenomenon translates when participants are explicitly encouraged to think about their choice rather than when they make selections implicitly (Barlas, 2016). Since games afford a variety of choices, some which are implicit while others where players are urged to explicitly think, we should be able to test where *equivoque* works and when the trick becomes obvious.

For an *equivoque* to land successfully, magicians have to carefully construct the setup of the trick. As an example, a magician (Elsdon, 2014) could set up a trick where they ask participants to choose a chocolate bar for the magician from a set of three.

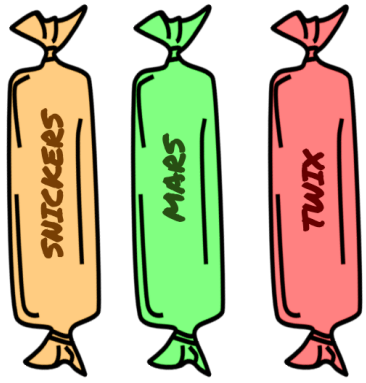

Fig. 7. The Magician sets the trick with three chocolate bars in a row

The magician would beforehand secretly predict an outcome, for instance, they would write in a piece of paper that, "Out of all the options, I would get the *Snickers* bar." Now, they would display the chocolate bars (*Snickers*, *Mars, Twix*) in a row (on a flat surface) and ask the participant to push two towards the magician. If one of the chocolate bars that the participant pushed was the *Snickers*, the magician would eliminate the third one and continue with these two. They would physically rearrange the *Snickers* and the other chosen bar and ask the participant to point at one.

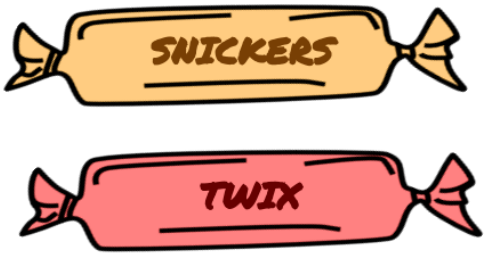

Fig. 8. The Magician rearranges the placements if one of the pushed bars were Snickers.

If the participant points at the other bar (*Twix*), the magician would eliminate that and take the *Snickers,* however if the participant had pointed at the *Snickers* bar, the magician would simply take that bar.
Alternatively, had the participant pushed *Mars* and *Twix* in the first step, the magician would have eliminated them, leaving the magician with the *Snickers*. The prediction would have stood true in all cases.

The *equivoque* in the example works because of two main things: 1) The phrasing instruction to make the choice is ambiguous (push/point) which does not promise any definite outcome giving the magician the scope to dynamically manipulate the interpretation of the participant's choice. 2) The options are more or less equal in value for the participant so that they don't get overly attached to their choice, making it hard for the magician to trick them. There are other reasons why an *equivoque* would succeed or fail, discussing those would be beyond the scope of our investigation.

Magic performances like these appear to involve lots of spontaneous social interactions when in reality they follow a fixed structure underneath. For example, in classic *cups and balls* (Christopher, 1996) routines, where the magician makes balls magically appear, disappear, transform and penetrate solid cups, magicians appear to genuinely interact with and respond to the audience in what they do with cups and balls, yet every move and word follows a careful script thanks to equivocation (and other techniques).

This situation maps neatly to e.g. the game design challenge of making non-player characters with pre-programmed and thus limited behaviours appear to engage in rich, varied, responsive interaction with the player. One immediate translation of equivocation here would be to script sequences of non-player character responses in such a way that they 'make sense' against any prior player action. At a higher level, the episodic game series *The Walking Dead* (Telltale Games, 2012) presents the players with a series of choices in trying to survive a zombie apocalypse that seem consequential while the major outcomes of each episode remain the same. For example, no matter whether the player chose to spare the character Ben's life in episode 4 or not, the game's script finds a way to have both outcomes lead to Ben's final death at the midpoint of episode 5. Still, players feel that their decisions 'count' as they are not aware of later pre-scripted events at the time of choosing. More subtly, while player choices do not necessarily change the outcome, they see how their decisions shape and express their own in-game character, Lee. More indirect translations would touch the actual underlying structure and game mechanics. For example, in the game *Her Story* (Sam Barlow, 2015), the player views video clips in the order they choose from a set of fictional police interviews to solve the case of a missing man. The player searches for a word and chooses one of the videos in which it was spoken to learn more about the case. 'Browsing an archive' is a game mechanic that makes immediate sense of content items appearing in a disjointed order.

Equivoque can be applied to games in a number of ways beyond narrative games. To present a snapshot of possibilities let's look at two potential implementations. A game resource could be ambiguously named like 'karma' or 'chaos'. Depending on the game these resources can be translated as the designer wants them to be perceived. For example, a high 'karma' could mean being transformed into a snake where 'snake' is implied to be a good avatar. Similarly, a low karma could mean the exact same thing. It should be noted here *equivoque* is not used to make a choice but to dynamically infer a series of previous choices that the player must have made to collect 'karma'. *Equivoque* can also be used in level design where the player could have a choice between a hole and a tunnel. If the player chooses the hole, the hole gets shut and the tunnel expands and if the player chooses the tunnel, it has the exact same outcome. This can be implemented in a variety of ways by assigning meanings to game objects once the decision of using that object is made by the player.

Discussion and Conclusion

The art of stage magic has developed and fine-tuned centuries worth of tried patterns, principles and techniques in affording and steering audience experiences that are increasingly underwritten by contemporary cognitive psychology. Like practitioners of any other art, game designers have long poached other fields for techniques and inspiration (W. Wright, 2001). Some game designers have pointed to magic as one such important source of inspiration (Donlan, 2015; Mullich, 2016; M. Stout, 2015; W. Wright, 2001; (Howard, 2014)), yet there has been little if any substantial demonstration of what kinds of techniques, principles and patterns could be used where. In this chapter, we illustrate in some detail how stage magic can offer a useful lens on crafting and steering player experiences in games. We have explained the principle of perceptual causality and how it can be used to better introduce the laws of a game world to players as part of on-boarding, craft enjoyable trajectories of suspense and surprise, and design surprising and non-frustrating puzzle sequences. We use stage magic as a lens to discuss these learning but principles of perceptual causality are foreground is other art forms like theatre and other kinds of storytelling. We have also introduced the concept of forcing, steering a perceived-free choice, and illustrated how several forcing techniques from stage magic can be used to enhance players perceived autonomy and sense of agency despite limited content and guide player attention without impinging on autonomy.

Notably, we do not claim that the discussed psychological mechanisms like perceived causality or visual saliency are in any way unique to stage magic or games: they are, to the extent psychologists have studied them, universal. We do believe, however, that in highlighting their fit with current concerns and practices in game design, we have contributed to the discovery of basic constructs and theories for game research to model, explain, and predict the impact of game design on player behavior and experience - and potentially, to instances where games and game design could serve as experimental petri dishes to further our understanding of said basic constructs and theories themselves. We also do not claim that the connected design techniques and principles discussed here are only found in stage magic. The choreographic pattern of setting up then breaking and building on expectations is also found in music (Scoates, 2013), for instance and other forms of art. However, any creative dialogue needs to start *somewhere*; stage magic's striking overlap with games in terms of what's presented in our work and other parallels like showmanship, consistency, visual deception make it a compelling candidate with which we hope to have highlighted some valuable starting points for

practitioners and comparative researchers. Furthermore, we wish to emphasise that any of the discussed parallels and suggested potential applications in games are at present untested hypotheses. Each of them require empirical work to probe their generalisability and boundaries of application from stage magic to games. Finally, we have not presented all potential cross-fertilisations between stage magic and game design. We only hope to have made the principled case that they exist and are worthy of further exploration by designers and researchers alike. We will consider ourselves successful if this work serves as a directed itch if not a fulfilling appetizer for its readers.

We would like to point out that although we present the similarities of stage magic and games in this chapter, we do think there are also some considerable differences. The pacing of a stage magic trick is much different than that of a game as the control is completely in the hand of the magician. In games often this control is shared between the player and the game. Another feature of games that is different to how a stage magic trick plays out is repeatability; not just of the entire game but game sequences (failing and restarting or simply restarting) is. We suggest keeping these and similarly other differences in mind when transferring techniques between stage magic and games.

Lastly, as discussed above, there is no systematic analysis of how stage magic can be applied in games. Our work so far unpacks stage magic recognising its potential of eliciting epistemic emotions. It piles a multitude of hypotheses, needing a stricter scope and investigation using established research methods to back our claims. As demonstrated, forcing, especially *equivoque* is a powerful tool to create an illusion of choice for players as it promises a genuine free choice. This quality of *equivoque* allows dynamic manipulation of free choices offering a wide scope of implementation as shown above. Its reliance on semantic ambiguity (i.e. ambiguity in phrasing the setup of the choice which allows multiple interpretations) lends itself directly to choices in story narratives. Making *equivoque* a more obvious starting point for investigation in terms of creating perception of choices and thus uncertainty and dilemmas that accompanies such an illusion.

Chapter 6

Zeroing in on Equivoque for Game Narrative[4]

As discussed, *equivoque* drives people to a predetermined outcome by exploiting semantic ambiguities (i.e. ambiguity in phrasing the setup of the choice which allows multiple interpretations) and their failure to notice inconsistencies. Double entendre phrasing of choices actively involves the spectator in decision making even if they have no impact on the outcome (Pailhès et al., 2020). Practitioners claim that the deception in an *equivoque* is fairly strong and repeatable without becoming apparent (Maven, 1992, 2011).

Based on our research (Chapter 5, section Equivocation) we suggest that *equivoque* can be an effective tool for building choices, especially in game narratives due to its usage of wordplay. Since we hope to apply principles honed by stage magicians to elicit *decision uncertainty* that is motivating to players through illusory choices, we look towards *forcing*. Amongst the forces discussed in the last chapter, *equivoque* is the one of the forces where the participants have a genuinely free choice but the outcome of their decision is manipulated. If players see these choices as free and believe that these choices have an impact on the outcome, they have a high likelihood of experiencing motivating *decision uncertainty* (see Chapter 4).

Fundamentals Behind the Working of Equivoque

We think we control events more than we actually do (Langer, 1975; Presson & Benassi, 1996) and assign causality between unrelated events (Blanco et al., 2011; Matute et al., 2011, 2015). This is described as "the mind's best trick" (Wegner, 2003) of experiencing "conscious will". If an outcome follows our action, in hindsight, we attribute our action as the leading cause behind the unrelated outcome, providing an illusion of autonomy. Choice blindness is a cognitive failure which glaringly illustrates how we fail to detect the mismatch between our choice and its outcome. Given a choice between two items, studies show that people consciously choosing a particular item fail to

[4] Some parts of the literature in this chapter is published work (Pailhès et al., 2020). Shringi Kumari is the second author on that paper.

notice the change when they end up with another item after the experimenter switches the chosen item with the rejected one. They justify the outcome as their original choice which suggests that we have poor insights into the cognitive mechanisms that drive our choices (Hall & Johansson, 2008; Johansson et al., 2005). In other words, we accept the switched outcome as our own constructing a false sense of control based on the outcome of our choice (see also (Nisbett & Wilson, 1977). Unlike choice blindness, *equivoque* principles do not rely on deceptively switching outcomes but exploit linguistic ambiguities, and our tendency to ignore inconsistencies.

To function optimally in our daily lives, we are highly adaptive and tolerant of distortions to facilitate comprehension (Erickson & Mattson, 1981; Shafto & MacKay, 2000). For instance, *Moses Illusion* illustrates: when asked "How many animals of each kind did Moses take on the Ark", most people answer "two", even though they know that it was Noah who took the animals on the Ark (Davis & Abrams, 2016; Erickson & Mattson, 1981; Song & Schwarz, 2008). This shows how we fail to notice anomalies despite knowing the correct answer due to not having a chance to fully process the question (Bottoms et al., 2010). Like *Moses Illusion*, it is possible that *equivoque* procedure is successful because people omit the possible inconsistencies happening to their choice (Pailhès et al., 2020).

Potential Usage in Game Narratives

Equivoque allows a number of ways in which artificial choices can converge to the same outcome. However, in the most classic *equivoque*, twisting of the outcome is immediate. For instance, when a magician would say "touch one card", the card touched would then immediately be *discarded* or *kept* for the force to play out as planned. This is not the same as *The Walking Dead* (Telltale Games, 2012) example given above which follows the same principle but the story does not converge immediately, instead the players go through other story points before they land at the same main story beat.

There are different ways of structuring stories in games (Ashwell, 2015; Lindley, 2005; Short, 2016, 2019). It is not necessary for us to go into the details of narrative design however it is important to understand that developers have been trying to find ways to optimise story structures for desired effect with limited content (Short, 2016, 2019). One basic quest is to reduce production cost without compromising on engagement (Koster, 2018). In addition to that it is also important for designers to steer the player in the direction of most optimal experience. Designers use a variety of terms

to explain narrative structures, for our purpose we use the following definitions: (1) Nodes are vertices at which the story progresses. Start node being the beginning of the story and end nodes being all last nodes at the final level of the story, where the story ends. (2) Links are connections between two nodes; two nodes can have multiple links between them. (3) Last of all, branches are all the unique paths (collection of links) that connect the start node to any of the end nodes. Developers write more branches for multiple reasons: variety, replayability, depth. However, at the same time they strive to limit the number of branches for production reasons, hoping to provide players with enough interesting decision points (Short, 2019).

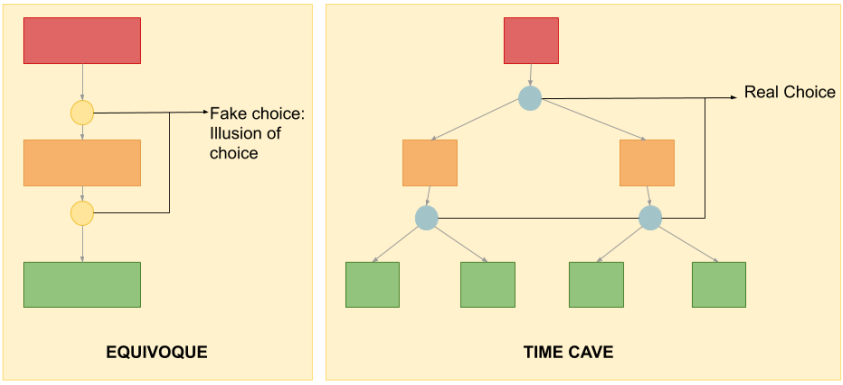

Fig. 9. Narrative structures of **(a)** Classic *Equivoque* **(b)** Time Cave (Ashwell, 2015)

As seen in Fig. 9, the *equivoque* structure has three nodes from start to end and one branch while a *Time Cave* (Ashwell, 2015) often used in CYOA (choose your own adventure) structure has seven nodes and four branches. There are multiple other story structures but we use the Time Cave for comparison as it is the most extensive with at least one unique link between two nodes. If we look at *The Walking Dead* (Telltale Games, 2012) structure, it is a *Branch and Bottleneck* (Ashwell, 2015; Short, 2019) (see Fig. 10) which is basically a compilation of mini time caves that converge at certain nodes via fake choice or without any choice in between nodes.

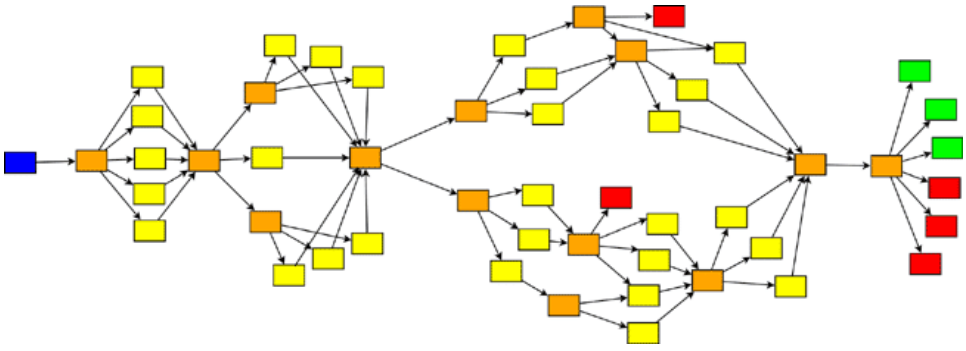

Fig. 10. An elaborate Branch and Bottleneck section illustrated by Sam Kabo Ashwell (Ashwell, 2015).

The production cost of any story is directly related to the number of branches it has, however, in the first play the player would encounter just one branch between the start and end node. With our analysis of *equivoque*, we believe that it can play an important role in drastically reducing the work done on narrative branches for the player to reach the same outcome with a similar player experience, at least for the first playthrough. One of the reasons to have a rich branching narrative is for its replayability value, i.e. every time the player engages with the game, they get to explore alternatives. It is worth testing how *equivocation* fairs on this aspect of game development.

Types and Structures of Equivoque

Equivoque is a broad technique that magicians use in their customised ways to operationalise the force around their pre-scripted outcome (Pailhès et al., 2020). We have synthesised information on types of *equivoque* by analysing tricks and following the available literature. Below, we discuss a few applications of *equivoque* with stage magic to get a deeper understanding of its structures than can be applicable to game narratives.

Classic Equivoque Variations

This the basic *equivoque* we have discussed in the previous sections where the outcome is manipulated based on the magician's script. For a successful *equivoque*, the magician lays down verbal groundwork for potential multiple interpretations (Elsdon, 2014). The stress is on making the setup ambiguous and open to outcomes.

Variations in a classic *equivoque* comes from the variety in phrasing according to the decision framing the magician desires. The phrases change the interaction between the trick and the participant. For instance, 'push' or 'touch' involve physical interaction with the objects while 'point' is more detached. Within games, designers will have to take particular care about this phrasing to set up the following narrative or GUI (graphic user interface) interaction. For instance, using a phrase like pick one' to make a choice between two items might be too direct to offer interpretations however if the narrative tone of the game is abstract, a phrase like 'pick one' could still lead to an *equivoque.* Similarly, if the instructing game character is a shaman or has a habit of reacting in unexpected patterns, they may have the leverage to interpret choices more freely rationalised by their personality or abilities. In most cases the important bit is how the choice is set up, for instance, if it is said 'touch an item' on a selection screen without any context at all, the

designer can interpret the choice as they like. It could be interpreted as 'touch to select' or 'touch to discard'. On the other hand, within the context of the game, actions like 'touch' or 'push' might already have some assigned meanings, for example, pushing an item towards an NPC may leave little space for the designer to 'discard' the item if previously pushing meant 'selecting'.

Another variation in the classic force is how tightly the set up phrase is coupled with the outcome. It could have immediate impact, for e.g., touch a card and then immediate interpretation of that touch as keeping the card or discarding it. In contrast, the outcome could be decoupled with the set up, for e.g. setting up a deck divided into two and then asking "which set of cards would you pick" and genuinely going forward with the chosen deck to eventually reach the same outcome (both decks being identical). Here the magician has used two kinds of forces to set up and execute the *equivoque*.

Hidden/Open Equivoque

The classic *equivoque* can be presented with options that look identical and have no apparent value for the audience, for example, face down playing cards or boxes. Here, the values of the cards or items inside the boxes are hidden and pose no or little value based bias that players can have while making the selection. On the other hand, the participants could be asked to make a choice between items they can openly see the values of, for example, different food or household items. Here, the participants clearly see the value of each item and then make a choice. There is evidence that *equivoque* works well in both cases, however the values have to be equally balanced if the *equivoque* is an open one (Pailhès et al., 2020).

Games can have unique applications for both hidden and open *equivoques*. As discussed above, applying equivocations with boxes, doors or identical paths would be hidden, whereas, the ones like narrative options or items that players can see (for instance, a weapon inventory) would be open equivocations. It is yet to be tested if one type is more effective in games than the other.

Equivoque Tree

The classic *equivoque* is stacked in a larger story where the magician frames a different set up question for each decision. For example, a magician sets up a trick (see Fig. 11) with multiple decision points leading to the participant choosing a *Snickers* bar for the magician.

Fig. 11. Example of an *equivoque* tree using open *equivoque*.

This is not a simple repetition of the same interaction to reduce the number of options which can be achieved by repeating a classic equivocation. Instead, it is a reconfiguration of the set up at each decision point. The magician first asks if the audience member has an odd or even temperament, then changes the arrangement of the chocolate bars and asks a different question altogether and so on. Such change of phrasing and set up escalates the deception and makes it harder for the audience to follow the trickery. This kind of funneling could be very uniquely applicable to situations in games where a non-player-character wants to lead another character to a particular outcome, making them feel that they had plenty of choice. It is quite complex to retrace the steps of an *equivoque* tree by the player to understand where the deception took place. We believe this embedded deception of a tree structure could allow replayability of a fake choice without the trick becoming easily apparent. For example, in an adventure game, the player could be served a number of reward options and told that based on how they respond they shall be rewarded, the narrator NPC could ask same set of questions as the magician: 'odd tempered or even tempered', 'left leaning or right leaning' and so on and while interpreting each choice as 'select' or 'discard', they also keep changing the layout of the rewards until only one item (pre-scripted by the game) is left. It should be tested, but we believe that the layered structure (from many to one) would make the deception less likely to be traced and more replayable.

Perspective Twist

Just like classic *equivoque*, the magician sets the stage so that the audience has a free choice. However, instead of manipulating the meaning of the action immediately they have one possible outcome that can mean different things based on the perspective of the reader (Elsdon, 2014). For example, the magician would have two items: pen and keys. The magician would have written a prediction note saying "you will have the pen and I will have the keys". Now the magician would ask the spectator to pick an object. If the spectator picks the pen, the magician picks the prediction and reads it out. On the other hand, if the spectator picks the keys, the magician would ask the spectator to read the text, making the outcome accurate in either case. This is even more effective with multiple items using classic *equivoque* in the first stage. When it comes to games, this is another method a single outcome could be made to look as if it were custom for each choice. This could be done via an NPC or through the environment, however since games are not real time, the illusion may not land as well. This trick comes handy in mind reading set ups, however in games, mind reading is not believable as the computer can adapt to new data and the user might not believe that an outcome was

predicted in advance. That said, this could be applied in synchronous multiplayer games where all the game needs to do is direct who reads out the outcome.

Discussion and Conclusion

As pointed out earlier, there is no systematic analysis of how stage magic can be applied in games as yet. Thus far we have made our case by extracting and studying concepts from stage magic literature, stage magic performances and mapping them to games. To substantiate our claims, we need to go further by defining a strict scope and conducting investigation using established research methods in hope to back our claims made so far.

Equivoque forces the spectators to choose a certain object while the spectators believe that they made the choice out of their free will. This makes them curious of the outcome (Olson et al., 2013; Ozono, 2017) making force useful for invoking motivating uncertainty. We think forcing, especially *equivoque* is a powerful tool to create an illusion choice for players as it promises a genuine free choice and builds on the psychology of people's inherent choice blindness. While games already do this using structures like 'branch and bottleneck' to converge at a common node, an *equivoque* should provide one way to create an absolutely linear structure with no branches at all feel like it has branches. Moreover, we are suggesting to test these structures in their effectiveness to specifically create the player experience of motivating *decision uncertainty* which has not yet been tested with that focus.

For successful *decision uncertainty* that makes players want to further engage in the game, they need to be able to make choices. In their perception these choices need to (1) feel free to begin with and (2) they should feel that their choice has an impact on the outcome (see Chapter 4). From the literature above, we can say that *equivoque* does offer free choice, however we don't yet know if these decisions feel impactful to the players. We need to investigate if *equivoque* can create fake choices that give players the decision uncertainty that makes them motivated to resolve it and *outcome uncertainty* about the resolved state. For *equivoque* to be useful for games in terms of eliciting uncertainty that is motivating for players, we plan to inspect if choice illusion created with *equivoque* can create (1) feeling of *freedom of choice* (2) feeling of *impact*, thus creating (3) *decision* and *outcome uncertainty*.

As discussed in section 'Types and Structures of Equivoque', *equivoque* can be applied in multiple ways. We propose to start our investigation with classic *equivoque* within narrative games as they offer the most clean application of

the technique. That is, we can replicate the phrasing done with words to set the choice and manipulation of the outcome just like a magician would do. Furthermore, narrative games could clearly benefit on production time by adding choices to the game without having to produce content for each decision wherever possible. Being able to control the narrative while still giving the player's illusion of autonomy allows designers to keep their authorial control. By systematically comparing equivocations with Time Cave structure to see if *equivocations* create the same amount of motivating uncertainty (by making the players feel they truly have a free choice and their choices are impactful) we can conclude if our investigation in this direction is useful. We hope this serves as a starting and exemplary demonstration for looking into stage magic for inspirations beyond forcing and narrative games.

Chapter 7

Using Equivoque to Afford Motivating Uncertainty in Games[5]

Introduction

On investigating uncertainty, we concluded that *decision uncertainty* and *outcome uncertainty* are important player motivators. We call uncertainty 'motivating uncertainty' when players are motivated to resolve such uncertainty when they face it: by taking actions or by waiting to see the game's or other players' reaction. On reviewing stage magic principles, we have found *forcing* as a family of techniques capable of offering an illusion of choice. We have singled out *equivoque* as a starting point because of the genuine free choice it offers and exploitation of ambiguous linguistics that may fit game narratives.

We have identified that for an *equivoque* to work, the design requires two main things: (1) The phrasing instruction of the choice must be ambiguous. The setup must not promise any definite outcome giving the magician the scope to dynamically manipulate the interpretation of the participant's choice. (2) The options presented should more or less be equal in value for the participant so that they don't get overly attached to their choice, making it hard for the magician to trick them. There are other reasons why an *equivoque* would succeed or fail, testing which would be beyond the scope of our investigation.

Our analysis of *equivoque* and previous studies on forcing show that audiences buy the illusion of choice in an *equivoque* only if they feel a sense of agency (Chambon et al., 2014; Pailhès et al., 2020) over the choice (Pailhès & Kuhn, 2020a), i.e.: (1) They feel they have a truly free choice to make. (2) They feel that their decision had an impact on the outcome of their choice. As our grounded theory data shows, these are also key ingredients for *decision uncertainty* (see Chapter 4). If the player does not think that the choice is impactful, they have no reason to be in any dilemma about the decision they need to make. Similarly, if the players do not feel they have full freedom, that is, they are being forced to make a particular choice, they would lose the

[5] The first study described in this chapter is also published work (Pailhès et al., 2020). Shringi Kumari is the second author on that paper.

autonomy on the resolution of the decision diminishing their *decision uncertainty*. This uncertainty about the decision should impact their curiosity regarding the outcome leading to *outcome uncertainty*. From our study of m2m motivation, we know that solving uncertainty is a valuable motivator for players (see Chapters 3, 4 and 5). While there are seven kinds of uncertainty that can be motivating, we focus on *decision uncertainty* and *outcome uncertainty* with which the concept of *equivoque* (creating illusion of choice) shows to have the most direct mapping.

The main question that remains unanswered is whether *equivoque* can actually create an illusory choice that stokes *decision uncertainty* in games. Answering these questions is the subject of the studies presented here. The two main questions that we propose to answer the main question are: (1) Do players feel motivating uncertainty and required sense of agency when they interact with an *equivoque* choice in a game? In a magic trick, magicians often only use *equivoque* once. In games, players typically engage in long sequences of choices. This may limit the applicability of *equivoque* to games if the repetition would make it more likely for players to see through the technique. Hence we ask a second question: (2) Is *equivoque* viable even when the technique is repeated over multiple choices within one game?

Since *equivoque* has not been formally studied by magic researchers, the first of the three studies is conducted to learn more about the technique within the field of stage magic before applying it to games. This would specifically test if *equivoque* offers impactful decision making to participants. By the popularity of *equivoque,* one can derive that it is effective but we do not specifically know if it is effective in terms of creating a sense of agency in the participants. To transfer and test the principle in games, we apply *equivoque* to a simple narrative adventure game, *Osaka.* In the second study, we compare a version with *equivoque* against a version with no choices to test if *equivoque* creates a higher illusion of choice. *Equivoque* is linear as in it is no choice at all (behind the curtains) as no matter what the player chooses we lead them to the pre-scripted outcome. This study tests if such a fake choice succeeds in creating any sense of motivating *decision uncertainty* in comparison to a transparently linear structure. In the third study, we repeat the *equivoque* over four choices and test it against a version with real choices and versions with interleaved choices (real and *equivoque* altered). To validate that *equivoque* has *worked* for games, we measure salient features that as we have studied creates motivation in players when posed with a decision: (1) *freedom of choice* and (2) perception of *impact* along with the main measure of (3) *decision uncertainty* and (4) (only for the second study) *outcome uncertainty* . In the following sections, to make the contrast between

real and *equivoque* choices apparent, we will refer to *equivoque* choices as fake choices.

Study 1: Validating Equivoque in a Card Trick

This study was conducted in collaboration with the Magic Lab at Goldsmiths. The main aim for us (games researchers) was to get a better understanding of the concept of *equivoque* before applying it to games. The workload was equally divided: we designed the study together, collected data together and did independent statistical analyses and discussed the inferences. During the data collection phase, the magic researcher executed the *equivoque* whereas the primary researcher of this thesis noted down the card sequences participants chose and noted down other observations. We took turns in debriefing.

Participants were to *choose* a card amongst four cards by making two choices. They were faced with four cards on a table and the researcher asked them to tap two cards. These cards were 'discarded' or kept' based on whether they would lead to the forced card or not. This sequence was repeated with two cards remaining on the table and the participant asked to tap one card, leading the participant to the forced card. We aimed to investigate the effect of manipulating the interpretation of participant's actions (touching a playing card) and deceptively leading them to the forced card on their sense of agency. We hypothesise that irrespective of the route they take to the forced card they would feel similar levels of sense of agency. Sense of agency is measured as: (1) the *impact* they perceive their choice had on the outcome and (2) *freedom of choice* participants feel while making the choice, using a questionnaire (see Procedure section below). This is done to get an understanding of how 'in control' of the outcome do people feel even if they make fake choices that in actuality have no impact on the result. We measure these salient features of motivating uncertainty but not uncertainty itself as the first experiment is not done in a game environment.

This study should tell us whether it is possible to induce an illusory sense of agency over the outcome of the choice, which is predetermined and objectively forced by the experimenter. As discussed, research on *Moses Illusion* suggests that people ignore semantic inconsistencies when they are presented within the context of a question, even when participants are encouraged to monitor for inconsistencies (Erickson & Mattson, 1981). Based on this we expected participants to disregard the inconsistencies in the experimenter's actions in response to their choices. We aim to investigate the efficiency of the *equivoque* procedure with respect to felt sense of agency in

participants regardless of the consistency of their actions with its inference and thus the outcome. That is, we hypothesise that (1) whether the first time the participants tap was inferred as 'keep' the cards and the second time it was inconsistently inferred as 'discard' the card and vice versa or (2) whether both times the actions were inferred consistently as 'keep' or 'discard' should not impact their sense of agency. While magicians use *equivoque* and that shows its effectiveness, a study like this tests the phenomenon specifically with context to sense of agency with respect to inference manipulation and tells us if there is difference in experience between the different routes participants can take. If we see that *equivoque* is effective in creating a sense of agency irrespective of the consistency or inconsistency of how participant's choices are interpreted, it gives us a solid ground to test this in branching narrative with respect to *sense of agency* and *decision uncertainty* in games where we can use *equivoque* to manipulate the interpretation of player's choice at each node.

Hypothesis

We predict that participants would feel high levels of *freedom of choice* and perception of *impact* over the outcome card even though they were manipulated.

H1: Our hypothesis states that the (a) *impact* and (b) *freedom of choice* participants feel will not change regardless of the path they traversed, even if the experimenter's interpretation of their action is inconsistent over the two choices.

Method

Participants

We conducted a lab study applying *equivoque* using playing cards. We recruited 97 participants: 56 female and 41 male in person at the Goldsmiths University. The average age of the participants was 27 (sd = 10.1), with the youngest player being 18 and the oldest being 67. We ran an a priori power analysis for a t-test with a power of 0.80, α=0.05, and a moderate effect size of 0.5. The output was a sample size of 101 participants. We excluded 4 participants from the analysis as the experimenter made some slight errors in the procedure, by using discrepant gestures while giving instructions to the participants.

Participants were informed that they will be participating in a decision making exercise using playing cards. None of the participants knew the concept of forcing, or were much familiar with stage magic. As *equivoque* has

not been scientifically tested previously, we based our estimation of the effect size on the confidence of magicians in the power of the principle based on magic literature.

Procedure

The card *trick* picked for the experiment is a standard *equivoque* technique. We picked a card trick to make sure that this kind of forcing is represented in its true form (Jones, 2004). Participants were given an information sheet about the study and asked for their informed consent. They were to make a series of two decisions on four cards to end up on a card of *their* choice. Four face down playing cards were laid out in front of the participants where the card third from their left was always the forced card (see Fig. 12). The experiment was conducted in a way that the participants would land on the forced card no matter what choices they made. The researcher did not know any of the cards other than the forced card (three of diamonds) and its position (third from participant's left). After the participants had their chosen card, the researcher would tell them what card they were holding (in the style of a reveal).

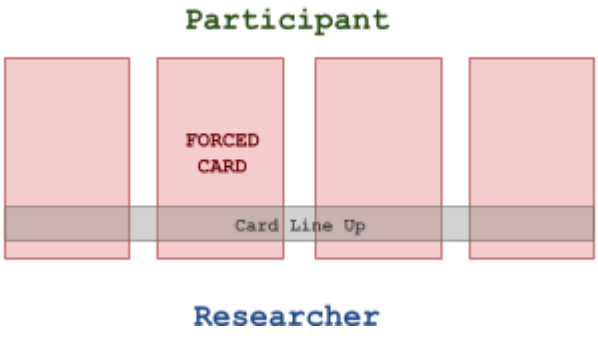

Fig. 12. A graphic representation of the experiment layout

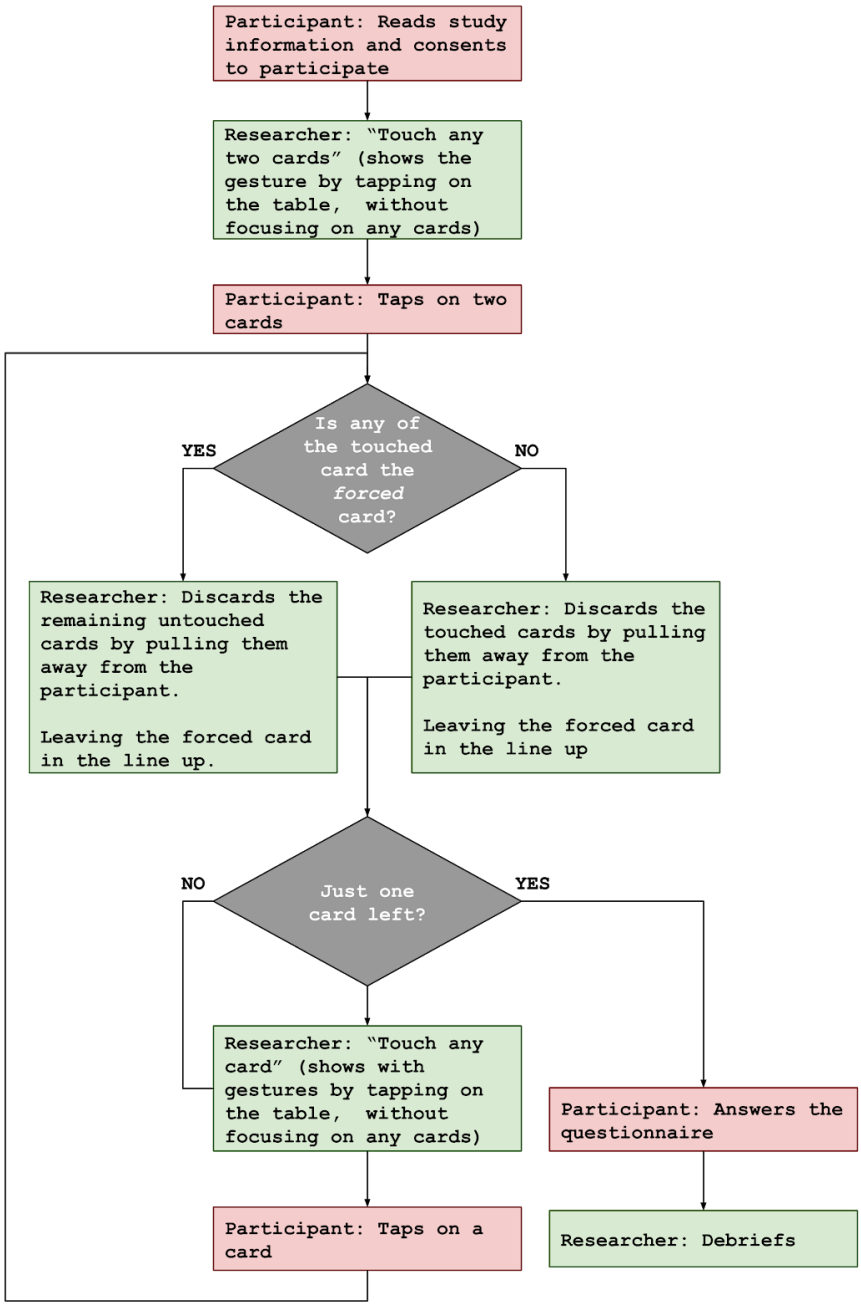

Fig. 13. Interaction flow of the card force study

Experiment flow is illustrated in Fig. 13. Participants were asked to gently touch (the touch movement was demonstrated by miming a tap) on two of the four cards. If one of the two touched cards was the forced card, the cards were kept and the remaining cards were discarded, otherwise, the touched cards were discarded. Cards were kept by leaving them in the line up and discarded by pulling them away from the line up towards the researcher. After this step, two cards were left on the table and the participants were asked to touch one of the cards. Again, if the touched card was the forced card it was kept and the other card was discarded. If the touched card was not the

forced card, it was discarded. This left the forced card as the participant's choice in all the scenarios. After the participants were left with one card their sense of *impact* and *freedom of choice* was recorded using two questions and by noting impromptu verbal reactions.

Conditions

Two experimental conditions based on whether the paths participants traversed were consistent or inconsistent:

(1) Condition Consistent: The cards participants touched as their choices were consistently kept or consistently discarded both the times. Two paths were considered for this condition:

(a) Path Keep-Keep - where both times, the choices they touched were kept in the line up

(b) Path Discard-Discard - where both times, the choices they touched were discarded from the line up.

(2) Condition Inconsistent: The cards participants touched as their choices were kept once and discarded the other time. Two paths were considered for this condition:

(a) Path Keep-Discard - where the first time their choice was kept and the second time it was discarded from the line up.

(b) Path Discard-Keep - where the first time their choice was discarded and the second time it was kept in the line up.

Measures

Participants were asked to answer two questions after their second choice:

1) On a scale from 0 (no impact at all) to 100 (extreme impact), how much impact did you feel your choices had on the final card?

2) On a scale from 0 (not free at all) to 100 (extremely free), how free did you feel to choose the card(s) you put your hands on?

We used these measures because they incorporate key components of a successful forcing technique (Kuhn, Amlani, & Rensink, 2008; Pailhès & Kuhn, 2019, 2020a). They are also pre-requisite conditions for people to care about the choices and thus feel dilemma or *decision uncertainty* related to it.

We chose a 0-100 scale based on previous research in forcing (Pailhès & Kuhn, 2020b). The questions were shuffled in sequence to avoid bias. After the participants answered the question the researcher predicted the card and asked them to pick and see the card. They were asked a few informal

questions to justify their answers. They were then debriefed about the experiment and explained the theory of forcing.

Results

Overall, participants felt a strong *freedom of choice* in touching the cards they wanted (M = 80.3, SD = 26.4), and a moderate perception of *impact* over the card they ended up (M = 53.1, SD = 35.2). Participants justified their answers by reporting that they did not feel a very strong sense of *impact* because only 4 of 52 playing cards were laid out to begin with. They reported that this restricted their scope given 48 cards were totally out of their control. This is in line with a previous study conducted to study another kind of force using playing cards (Pailhès & Kuhn, 2020b). However, it was apparent in the verbal interview that they did not realise they were being manipulated and the absence of a sense of strong impact was purely driven by the nature of the subject matter being four playing cards out of a deck of cards.

We examined whether path consistency influenced participants ratings. 52 participants experienced consistent routes and 45 experienced inconsistent routes.

Impact

As expected in H1(a), the *impact* participants felt their choices had on the outcome does not significantly change (see Fig. 14) between the two conditions. A Mann-Whitney analysis showed that the consistency of the routes did not affect participants' feelings of *impact* over the final card (W = 1078, p = 0.503, r_{rb} = -0.08).

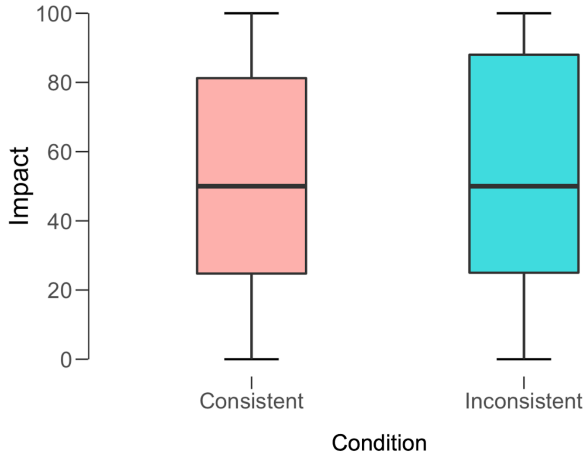

Fig. 14. Participants' perception of *impact* over the outcome (forced) card with respect to consistency of the *equivoque* routes.

The results contradicted our expectations as stated in H1(b). Participants reported significantly higher feelings of freedom over which card they chose (see Fig. 15) for the inconsistent than consistent routes (W = 1493, p = 0.015*, r_{rb} = 0.276).

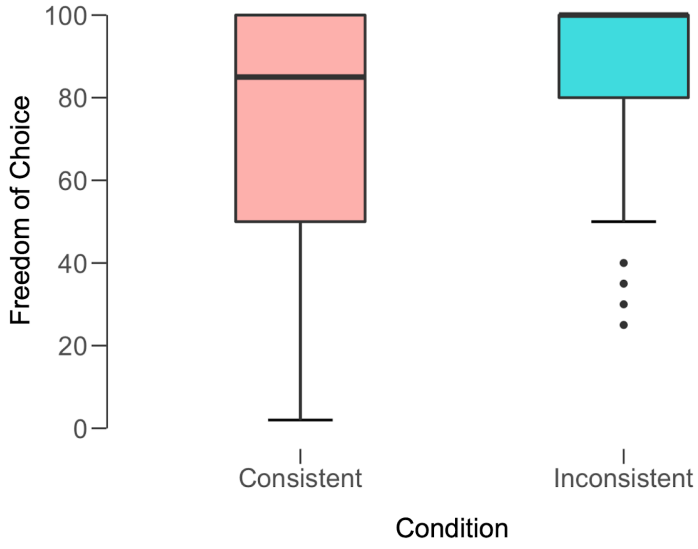

Fig. 15. Participants' perception of *freedom of choice* in touching a card with respect to consistency of the *equivoque* routes.

	Consistent		Inconsistent		W	*p*	r_{rb}
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact	55.44	35.47	50.28	35.13	1078	0.50	-0.08
Freedom of Choice	74.32	29.15	87.24	20.94	1493	0.015*	0.27

Table 5. Summary descriptive statistics of *impact* and *freedom of choice* people felt in Consistent and Inconsistent conditions

Due to the unexpected results, we investigated the four different decision paths more closely. We separated each path described in the Conditions section (see above) by separating them into four conditions: two consistent (Keep-Keep and Discard-Discard) and two inconsistent (Keep-Discard and Discard-Keep). Both measures were individually compared across the four conditions. 31 participants experienced the Keep-Keep path, 21 participants experienced the Discard-Discard path, 23 participants experienced the Keep-Discard path and 22 participants experienced the Discard-Discard path.

Impact: Individual Paths

The *impact* participants felt their choices had on the outcome does not significantly change (see Fig. 16) with the path they traversed. This was demonstrated using a Kruskal-Wallis test which showed no significant effect of the different routes on participants' sense of *impact* over the outcome card ($X^2(3,97) = 0.98$, $p = 0.806$, $\eta^2 = 0.010$). Speculation: although not significant, we also see that *impact* people felt in the path Keep-Keep is slightly higher than other paths. The reason could have to do with the gesture of keeping the card that the players touched is the most 'natural' or 'expected gesture'.

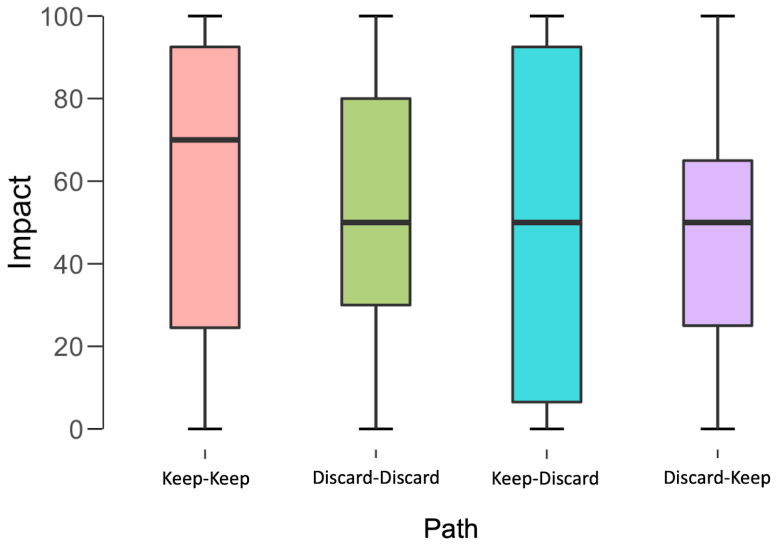

Fig. 16. Participants' perception of *impact* over the outcome (forced) card with respect to the path or sequence of events they experienced.

Freedom of Choice: Individual Paths

Surprisingly, the *freedom of choice* participants felt while making their decisions does show a significant change with the path they traversed ($X^2(3, 97) = 8.68$, $p = 0.034$*, $\eta^2 = 0.079$) (see Fig. 17). More specifically, a deviation contrast analysis showed that one specific inconsistent path (Keep-Discard) led participants to feel significantly freer for their choice ($t(93) = 2.52$, $p = 0.013$*).

To study how this path compared to the rest of the three paths, we conducted a post hoc Tukey analysis. We did not find any significant difference between any two groups. The Keep-Discard path shows a closeness to a significant difference compared to the Keep-Keep path ($t(95) = 2.58$, $p = 0.054$, $d = -0.84$) supporting the deviation tendency.

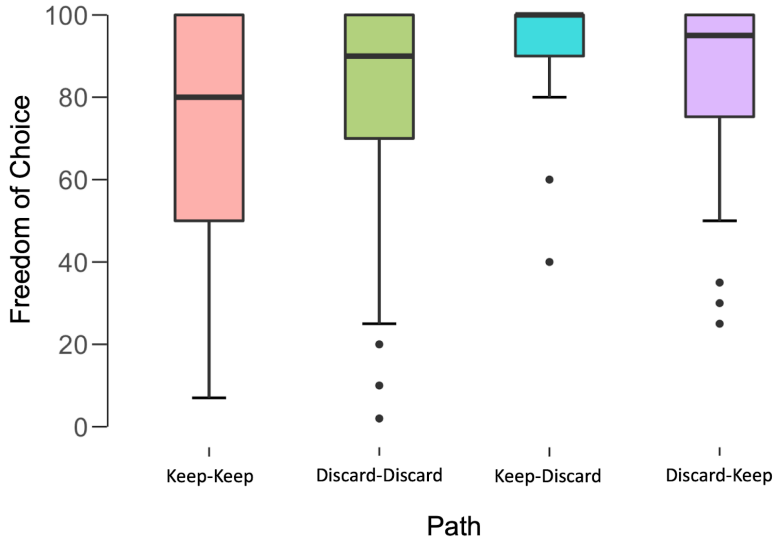

Fig. 17. Participants' perception of *freedom of choice* over the outcome (forced) card with respect to the path or sequence of events they experienced.

	Keep-Keep		Discard-Discard		Keep-Discard		Discard-Keep		X^2 (3,97)	*p*	η^2
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact	58.06	36.62	51.57	34.21	51.08	39.27	49.45	31.11	0.98	0.80	0.01
Freedom of Choice	74.12	25.48	74.61	34.53	92.39	15.06	81.86	24.94	8.68	0.03 *	0.07

Table 6. Summary descriptive statistics of *impact* and *freedom of choice* people felt across all four paths

None of the participants expressed that they understood the trick or understood that they were forced towards a specific card. The usual reaction after the experimenter made a predictive 'guess' was that of utter surprise. Some participants suspected that all cards might be the same (they were all different) and looked at all the other cards to check if their hunch of all cards being the same was correct.

Discussion

These first results suggest that the *equivoque* is an effective forcing technique where the sense of agency in participants is not diminished irrespective of the manipulative and inconsistent inferences of their actions. We considered paths Keep-Keep and Discard-Discard as consistent and the other two as inconsistent. The inconsistent paths change the interpretation of the participants' identical action of touching over the two choices. Looking at the

above results, we can say *equivoque* was successful in providing participants the illusion that they impacted the outcome by selecting one item out of four. They felt they had a role in deciding the outcome despite the fact that they were completely manipulated and forced to end up with a predetermined card.

At this stage we are unable to find any testable reason explaining why participants felt significantly freer in the decision path Keep-Discard. This is something we suggest needs further probing. We suspect it had something to do with the gestures and the setup. We do not expect to see this when we transfer the trick to games. Given the strong first indications we design a narrative game to test the phenomenon in games.

Study 2: Using Equivoque to Invoke Uncertainty in Games

This study was designed to answer the research question: Do players feel a sense of agency and subsequently motivating uncertainty when they encounter an *equivoque* choice in a narrative game? In other words, does *equivoque* work for narrative choices in a game context?

From the grounded theory study on uncertainty (Chapter 4) we focused *decision uncertainty* and *outcome uncertainty* as they are both related to choice. We also know that for these uncertainties to be motivating towards their resolution, players should feel they have made an impactful decision and that the choice was free in nature. Following the lab study, *impact* and *freedom of choice* continued to be dependent variables to see if players feel that sense of agency prerequisite for motivating *decision uncertainty* and *outcome uncertainty* (see Chapter 5). We also explicitly measure *decision uncertainty* and *outcome uncertainty* to test if they are actually being elicited even when the presented choice is fake.

Hypothesis

We hypothesised that:
H1: People will feel higher (a) *impact*, (b) *freedom of choice*, (c) *decision uncertainty*, (d) *outcome uncertainty* when presented with an *equivoque* choice (fake choice) in comparison to when they are presented with no choice at all.

Furthermore, within the fake choice condition we hypothesised that:

H2: People will feel similar (a) *impact*, (b) *freedom of choice*, (c) *decision uncertainty*, (d) *outcome uncertainty* no matter whether their choices are consistent or inconsistent with the outcomes.

Method

Participants

We ran an a priori power analysis (as the previous study) with a power of 0.80, α=0.05, and a moderate effect size of 0.5. The output was a sample size of 200 participants. Knowing the possible issues with online recruitment from platforms like *Prolific* (2020), in total we recruited 235 participants. 27 participants failed attention checks (listed in Materials section) and therefore their data was discarded. 208 participants - 103 female and 100 male and 5 who preferred not to say – participated in total. The average age of the participants was 26.04 (sd = 8.74), with the youngest player being in the age group of 18 to 25 and the oldest from the age bracket of 45 or older.

Participants were recruited from an ethnically diverse participant pool as long as they were fluent in English. Being a gamer was not part of the requirement especially because the playtests were done on both gamers and non-gamers without seeing much of an effect. Participants were considered only if they could use a laptop or desktop to avoid the experience change on mobile where the text needs more scrolling and can seem longer.

Participants were recruited online with attention checks in place. The reason for recruiting online was to have more ecological validity and make sure participants do not answer questionnaires under any pressure.

Material

The Game

Following the lab study, we created a narrative game *Osaka,* where the player plays as a tourist who goes through an unforeseeable adventure. The interactive fiction game was made using the game engine *Twine* (Klimas, 2009). The game was designed to be played on any browser on a laptop or desktop. In *Osaka*, the player plays as a young tourist who is visiting *Osaka* and knows very little about the city, its culture or the language. She enters a tricky position when her friend Caron who was going to be her host abandons her. The game poses a question when the protagonist meets her friend for dinner and things start to get risky. The game poses a single question which makes the player make a choice. This decision point is *equivoqued*, which means no matter what the player chooses, the outcome remains the same.

Osaka was created this way because it is simple and has a single question so that it remains as clean of bias as possible. The story is given enough depth that people start to care and the choices offered are similar instead of one option with an obvious higher value for the players. It was also designed to be easy to pick and play, the only restriction being that players could read the English text. We checked these criteria via playtests. The game had no music or sound effects. The game could be played in 3 to 5 minutes, the play session was kept between 2 to 10 minutes to mimic average play sessions of games we used to study m2m uncertainty (Chapter 4) .

It could be argued that a single narratively embedded choice is too bare-bones to constitute a 'full-fledged' game. Arguably, for generalisability *Osaka* can be viewed as a story snippet or storylet (Short, 2019) that can both stand alone or be embedded across the spectrum of game narrative structures (Ashwell, 2015; Short, 2016). It is important to note that such a storylet can serve the gamut of narratives games including: adventure games with embedded puzzle or action mechanics like *Life is Strange* (Dontnod Entertainment, 2015) or *Heavy Rain* (Quantic Dream, 2010); or simple interactive fiction like *Queers in love at the End of the World* (Anthropy, 2013), a popular hypertext game created with Twine.

Game Design

The game design was restricted to one decision point for the study. In addition to this we wanted to create a story which was engrossing for the players such that they care about the choices presented to them. We created the story by iterating and playtesting both the story and the options. We went through an iterative process as it is known to help games find the right equation with the audience (Keith, 2010; Luton, 2009; Macklin & Sharp, 2016). We performed regular playtests to ensure that the intended usability and experience of the game are in line with how players actually perceive it (Extra Credits, 2012; Fullerton et al., 2004). The game went through multiple iterations play-tested by five players. These players matched the participant recruitment criteria (see section Participants). They were recruited online through a pool of social networks.

Iteration 1

The first design iteration was mimicking a classic narrative design around a single choice with limited context. In this story setting the player and their friend are venturing on what the player perceives as a semi-dangerous adventure. The friend advises the player to pick a tool to defend themselves in case of danger. Two weapons in sight are an axe and a pistol. The phrase

"pick one for me" to set the *equivoque* was taken from a magic performance by Mark Elsdon where he asks an audience member to pick a chocolate brand from two options (Elsdon, 2014).

> You and your friend are planning a visit to a farm. She warns you that the farm is infested and has some horror stories attached to it. You ask, "like what?" She tells you about the giant rodent infestation myth. You don't think much of it but she insists, "Come on Joe, I think we must. Pick one for me"
>
> - Axe
> - Pistol

In the first iteration we focused on a simple story with an almost impactless choice. On testing the above version with two players we realised that the story is not enough for them to care about their character or their choice in the game.

For the second iteration, we wrote and tested an expanded story to see whether this helped people to care about their character or not.

Iteration 2

> You are new to the city of Osaka. Enamored, but mostly just nervous.
>
> You have always wanted to visit Japan, but you did not think you would feel so stranded. It could be simply because your hotel is too far into the insides of the city. It could be because you have not travelled alone in a while...
>
> Or, because your friend Caron who was to show you around Japan, who told you not to start in Tokyo (like every other lame culture enthusiast), who was going to show you the most fabulous of *izakayas* - changed her mind - just like that. What a rat! Anyhow, she has *kindly* offered to come visit you in your tiny hotel room to give you travel tips. Sure. At least for the night you have a plan.
>
> - Next

She comes. It's surprisingly nice to see her, especially to hear her voice. You feel at home, and start to feel confident about your trip. It is getting late - you want her to stay, but you don't say it - she abandoned you after all.

You are about to say your goodbyes, when you hear loud voices in languages you don't understand, blast through the window. She is as alarmed as you are. There are more penetrating voices, now coming from the corridor as well. What?!

She looks confused, "Why are they doing this? We should get out of here." - she says in a hushed tone.
You are part scared, part clueless, "Why are they doing what?" No reply. You can see she knows more than you, but wouldn't say. You look around, "Well, we can't possibly get out of here. There is this tiny window and I am guessing the front corridor isn't clear."
She says, "Who knows. Maybe it is, maybe it is nothing". Crazy noises continue.
You stare blankly. "I don't understand"
"Gosh, we should hurry" she cuts you off, "pick one for me."

- Front Door
- Window

We play-tested with five players and all of them were engrossed in the game as they related to the character and wanted to continue. They also enquired about what happens next.

> "*I like the story because it had a lot of elements that I may find myself in between.....foreign land…solo travel...cheap hotel....a local guide shaped traitor who gets me killed*" [p1]

> "*Yeah... my immediate thought was... I'm a big girl with zero upper body strength and I don't fit into windows... so.... the front door seemed the only plausible option for me.*" [p2]

> "*[I] Would like to know more about the story. I love games with stories you know.*" [p3]

Playtester comments indicated that our version posed a choice which invoked deliberation and *decision uncertainty*:

> "*I did not know with surety that my choice (window) was the correct one. Seemed reasonable but in a foreign land my reasoning may be quite unreasonable for the locals.*" [p1]

Given that, we then focused iteration on the exact phrasing of the *equivoque*.

In Elsdon's tutorial, he explains how the phrase "pick one for me" can mean both: (1) "Pick one, *for me*" that is pick an option for themselves for the sake of the trick or for the sake of Elsdon. In this case the chosen chocolate would be taken by the audience member and Eldson would get the discarded chocolate bar. (2) "Pick one for me" would literally mean picking one of the chocolates for Eldson, leaving the other for the audience member themself. This is why the second iteration of the game kept the same phrasing with a newer storyline. On playtesting that version, we realised that the phrasing does not transfer to this game scenario as well.

> "*And even if I chose that, it seems like the other character is the one taking the decision for me so I felt I had not much impact on the story.*" [p3]

We did quick iterations with the phrasing trying to incorporate phrases like "Pass that", "Take that" instead of using the word "Pick". We had to change the storyline and choices a bit to accommodate these phrases.

Example Iterations

"Stay put, I will check", she cuts you off and goes into the corridor. You don't know what to do. Within minutes she is back, slams the door behind her, looks around as she pants and says, "Take that."

- Scissors
- Knife

"Stay put, I will check", she cuts you off and goes into the corridor. You don't know what to do. Within minutes she is back, slams the door behind her, looks around as she pants and says, "Pass that."

- Scissors
- Knife

Based on playtest results we realised we weren't able to strike the balance of interesting story and choices with the needed ambiguous phrasing to set up the *equivoque*. This motivated us to go back to the original design (Iteration 2) and work the *equivoque* with that narrative. We added "which way" instead of "pick one for me" keeping in mind that for an *equivoque* to feel real, it needs to have an ambiguous setup and a choice that has identical outcome.

> "*The choice I made has more impact than I thought earlier. Both characters are going out the same way*" (this player had played previous versions so knows the outcome), "*but the choice I made this time was accepted*" [p1]

Final Version

(Set up text same as Iteration 2)

You are part scared, part clueless, "Why are they doing what?"
No reply. You can see she knows more than you, but wouldn't say.
You look around, "Well, we can't possibly get out of here. There is this tiny window and I am guessing the front corridor isn't clear."
She says, "Who knows. Maybe it is, maybe it is nothing". Crazy noises continue.
You stare blankly. "I don't understand"
"Gosh, we should hurry" she cuts you off, "which way?"

- Front Door
- Window

[Window]
"Alright. You climb down the window, that way you don't have to interact with anyone. I will walk down the corridor and talk my way through, if they don't kill me first." She chuckles. "Don't

worry, run when you get downstairs and I will see you around the second block.

It will be okay, try not to panic."

[Front Door]
"Alright. I can walk down the corridor and just talk my way through, if they don't kill me first." She chuckles. "You climb down the window, that way you don't have to interact with anyone. Don't worry, run when you get downstairs and I will see you around the second block.

It will be okay, try not to panic."

Game Conditions

The study was conducted across two main conditions.

Condition No Choice: The players were given the story in which the character guiding the player poses a decision. However, she thinks they need to hurry and have no time to ponder so the player gets just one option. Each participant was randomly given either 'Front Door' or 'Window' as their sole option to ensure the text of the different options did not affect the results.

Example, Random Option 'Front Door'

You are part scared, part clueless, "Why are they doing what?"
No reply. You can see she knows more than you, but wouldn't say. You look around, "Well, we can't possibly get out of here. There is this tiny window and I am guessing the front corridor isn't clear."
She says, "Who knows. Maybe it is, maybe it is nothing". Crazy noises continue.
You stare blankly. "I don't understand"
"Gosh, we should hurry" she cuts you off, "which way?"

- Front Door

[Front Door]
"Alright. Being a tourist, you should be able to walk through the corridor without really interacting. Just pretend you don't understand anything - wait ... you don't need to pretend." She chuckles. "I will climb down the window. Run when you get downstairs and I will see you around the second block.

It will be okay, try not to panic."

Condition Fake Choice: The players were given the story then asked to make a decision between two options *Front Door* and *Window*. However, no matter which option they picked the outcome would remain the same (see Final Version in Game Design section). The options were visually shuffled in display order to avoid bias of any sort. All the randomisations were done programmatically to avoid any researcher bias.

Attention and Comprehension Checks

Since the game was to be played online without a researcher to monitor, we added attention and comprehension checks to make sure players actually read the text and were not distracted during the task. Additionally, since the study was conducted via *Prolific*, we wanted to cross check that the players were fluent in English (the language in which the story was told).

1) The game had multiple story screens. We recorded how much time players spent on each screen. We checked if they spent at least 40 seconds per screen. Through playtests we estimated that to be the minimum time it took participants to read the text. If they spent less than 40 seconds on any of the story screens we discarded their data.

2) Players were asked to answer a story related question (see below) in their own words. This would mainly verify that they are fluent in the language. Additionally, to also tell us if they understood the context of the story. People who left this box empty or answered unreadable gibberish were not considered for the data.

3) Only the players who finished the task within 8 minutes were considered to make sure that they were not distracted or left the browser screen for too long, if at all. Data of the players who spent more than 8 minutes or less than 3 minutes was discarded

Procedure

The study was a 'between participant' design, where two different groups of participants played the two different conditions so that the story is fresh to each participant. Participants were given an information sheet and asked for their consent and demographic details (age, gender). Participants were informed about their rights to withdraw. Participants would then play the

game. At the end of the game session they were asked to answer a few questions. Participants were not allowed to play again.

Measures

We re-used *freedom of choice* and *impact* measures from the previous study for comparability and closely maintained the phrasing for those two questions. We removed the context of playing cards from the questions. Unfortunately there are no existing questionnaires or other proven methods for recording player's *decision uncertainty* along with their *sense of agency* related to that decision. The closest to an existing validated scale is PUGS (Power et al., 2017), which captures the whole gaming experience, breaking down experiential facets that don't particularly fit m2m motivating *decision uncertainty*. This is why we created our own items for *decision uncertainty* and *outcome uncertainty*.

We iterated on the phrasing with playtesters until we saw evidence that participants understood them as intended. For *decision uncertainty*, with initial iterations of the questions we ran into the issue that players might feel *decision uncertainty* even before a choice is posed due to the narrative of the game. For example, even when there was no choice when asked, "Did you consider your options before making a decision?" A player reported:

> "*Yes, I thought of the alternatives and made a decision based on their consequences.*" [p5]

On probing further, we realised that the consideration was happening much before the players read the option. Thus, an open question was added during playtesting of various game and question versions to make sure that players understood exactly what we intended to ask. After multiple iterations we finalised the phrasing that best represented what we wanted to learn about *decision uncertainty* (see below). We kept the open question for the final study also as a comprehension check.

We finalised four questions to be answered using a sliding scale and one open question to be answered in the player's own words. We used a sliding scale (0 - 100) following the lab study format we used earlier. We took into consideration that categorical scales do not show significantly different results (Roster et al., 2015).

Participants rated the following question on a scale of 1 - 100:

1) *Freedom of choice* - How free did you feel to pick your option? Not free (0) to Very free (100)
2) *Impact* - How much impact did you feel your choice had on the outcome? No impact (0) to Very high impact (100)
3) *Decision uncertainty* - Did you weigh alternatives to make a decision? No at all (0) to A lot (100)
4) Open question - Please explain your rating on the above question (Did you weigh alternatives to make a decision?) in a few words
5) *Outcome uncertainty* - How clearly could you tell what the consequences of your choice would be? Not clearly at all (0) to Very clearly (100)

Ordering of the questions was randomised to avoid any bias due to sequencing.

Results

The results show that people feel a higher sense of *impact*, *freedom of choice*, *decision uncertainty* when there is a fake choice as opposed to no choice at all. The results also show that they feel similar *outcome uncertainty*. 100 participants played the Condition No Choice and 108 participants played Condition Fake Choice.

Impact

The results supported the hypothesis H1(a). Players felt significantly higher *impact* in Condition Fake Choice compared to when they played Condition No Choice (see Fig. 18). This was demonstrated by a Mann-Whitney analysis ($W = 3321$, $p < 0.001$*, $r_{rb} = -0.38$).

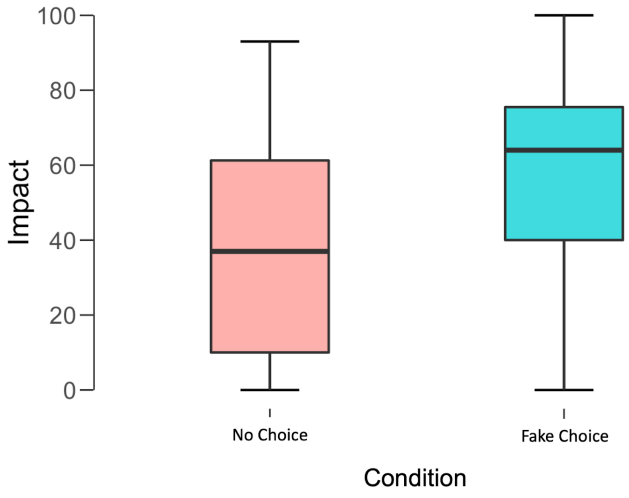

Fig. 18. Players' perception of *impact* over the outcome when they were given no choice versus when they were given a fake choice.

Freedom of Choice

The results supported the hypothesis H1(b). Players felt significantly higher *freedom of choice* in Condition Fake Choice compared to when they played Condition No Choice (see Fig. 19). This was demonstrated by a Mann-Whitney analysis (W = 1908.5, p < 0.001*, r_{rb} = -0.64).

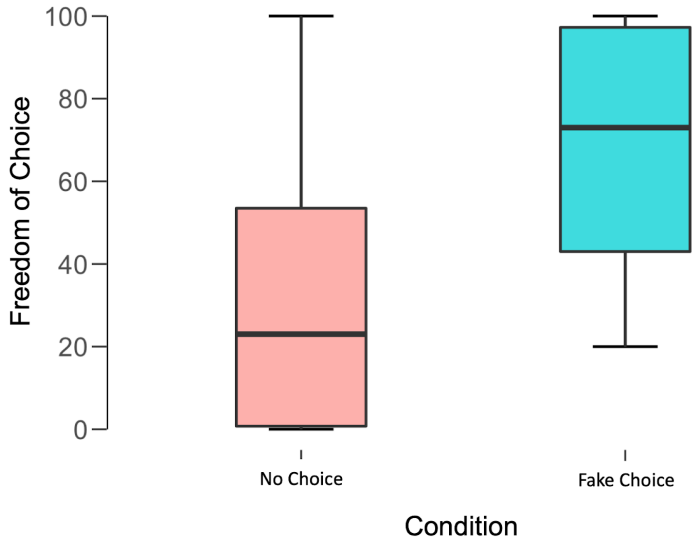

Fig. 19. Players' perception of *freedom of choice* in choosing an option when they were given no choice versus when they were given a fake choice.

Decision Uncertainty

The results supported the hypothesis H1(c). Players felt significantly higher *decision uncertainty* in Condition Fake Choice compared to when they played Condition No Choice (see Fig. 20). This was demonstrated by a Mann-Whitney analysis (W = 1234.5, p < 0.001*, r_{rb} = -0.77).

The open text comprehension check was also used to gain qualitative insight. Qualitative data supported our findings. For the No Choice version a player rated '0' and wrote:

> "*I did not (weigh alternatives) as i was already given a choice*"

On the other hand, for the Fake Choice version a player wrote:

> "*Yes, I had to weigh the alternatives presented (front door vs window) to make a decision of how to exit the room. I had to consider the potential*

consequences of using either exit. It was not a random choice." and another player wrote, "I guess I weighed the level of confrontation I would face to make the decision. I felt that I would face less confrontation or conflict going out the 0."

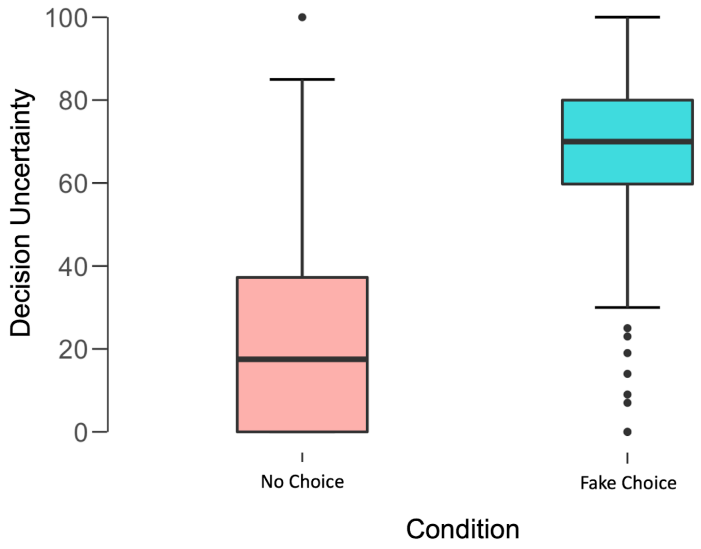

Fig. 20. *Decision uncertainty* players felt when they were given no choice versus when they were given a fake choice.

Outcome Uncertainty

The results contradicted our hypothesis H1(d). Players felt similar *outcome uncertainty* in Condition No Choice as in Condition Fake Choice. This was demonstrated by a Mann-Whitney analysis ($W = 5090$, $p = 0.475$, $r_{rb} = -0.057$).

This could be accounted for by the nature of the narrative where the players were curious about the outcome even if they did not partake in making the choice. The high means in both conditions (64.14, 61.16) show that players were curious of how the story progressed.

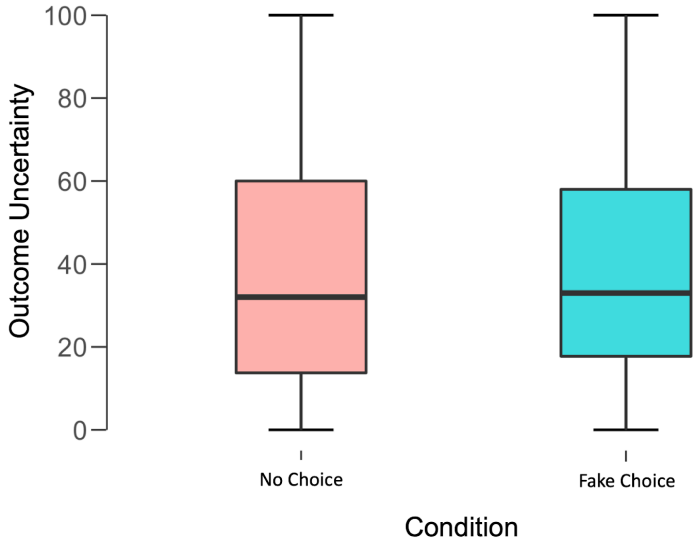

Fig. 21. *Outcome uncertainty* players felt when they were given no choice versus when they were given a fake choice.

	No Choice		Fake Choice		W	*p*	r_{rb}
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact	39.09	28.80	58.12	24.80	3321	<0.001*	-0.38
Freedom of Choice	30.8	30.04	68.89	26.94	1908.5	<0.001*	-0.64
Decision Uncertainty	23.36	25.11	66.56	22.69	1234.5	<0.001*	-0.77
Outcome Uncertainty	35.86	27.73	38.84	27.26	5090	0.47	-0.057

Table 7. Summary descriptive statistics of *impact, freedom of choice, decision uncertainty* and *outcome uncertainty* players felt when they had No Choice and when they had a Fake Choice.

We wanted to further explore any discrepancy within Condition Fake Choice. Within that condition, irrespective of the swaps, one option was always consistent with the player's choice. For instance, choosing the option *Front Door* would indeed lead the player out of the front door and the friend through the window. The inconsistent path would be choosing the *Window* but the player going out of the front door and the friend out of the window. As shown in the game text above (Final Version in section Game Design), the choice *Window* is consistent with the outcome whereas *Front Door* is inconsistent. We wanted to see if this consistency made players feel a higher sense of *impact*, *freedom of choice*, *Decision Uncertainty* and *Outcome Uncertainty*. Our hypothesis H2 states that we expect to see no difference in measures between the two paths, showcasing that the *equivoque* works.

We further analyzed the dependent variables based on the option chosen. We divided the data of Condition Fake choice into Consistent and Inconsistent paths. The path was considered Consistent if the outcome of the lead character was them leaving the room via the option they chose (Front door/ Window). The other route was considered Inconsistent. 57 participants took the Consistent path whereas 51 participants took the Inconsistent path.

Impact (Consistent vs. Inconsistent)

The results supported the hypothesis H2(a). *Impact* people felt in the condition with the consistent outcome was not significantly different from the inconsistent outcome (see Fig. 22). This was demonstrated by a Mann-Whitney analysis (W = 1245.5, p = 0.201, r_{rb} = -0.143).

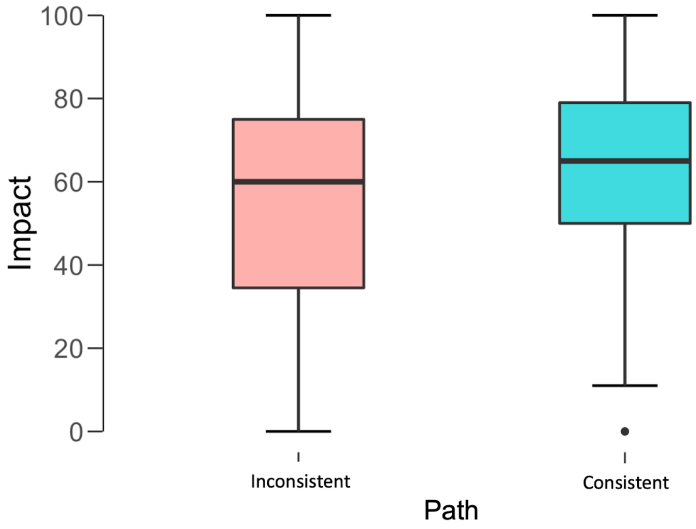

Fig. 22. *Impact* players felt when their decisions were consistent with the outcome versus when they were inconsistent

Freedom of Choice (Consistent vs. Inconsistent)

The results supported the hypothesis H2(b). *Freedom of choice* people felt in the condition with the consistent outcome was not significantly different from the inconsistent outcome (see Fig. 23). This was demonstrated by a Mann-Whitney analysis (W = 1368.5, p = 0.6, r_{rb} = -0.058).

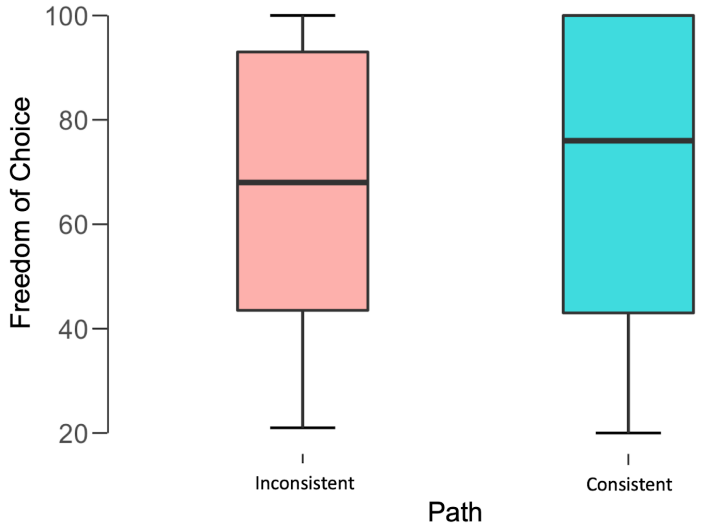

Fig. 23. *Freedom of choice* players felt when their decisions were consistent with the outcome versus when they were inconsistent

Decision Uncertainty (Consistent vs. Inconsistent)

The results supported the hypothesis H2(c). *Decision Uncertainty* people felt in the condition with the consistent outcome was not significantly different from the inconsistent outcome (see Fig. 24). This was demonstrated by a Mann-Whitney analysis ($W = 1378$, $p = 0.64$, $r_{rb} = -0.052$).

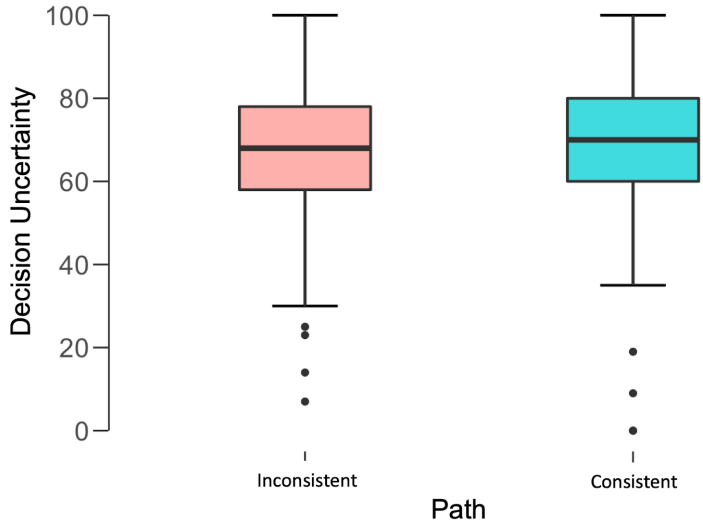

Fig. 24. *Decision Uncertainty* players felt when their decisions were consistent with the outcome versus when they were inconsistent

Outcome Uncertainty (Consistent vs. Inconsistent)

The results supported the hypothesis H2(d). *Outcome uncertainty* people felt in the condition with the consistent outcome was not significantly different from the inconsistent outcome (see Fig. 25). This was demonstrated by a Mann-Whitney analysis (W = 1608.5, p = 0.34, r_{rb} = 0.10).

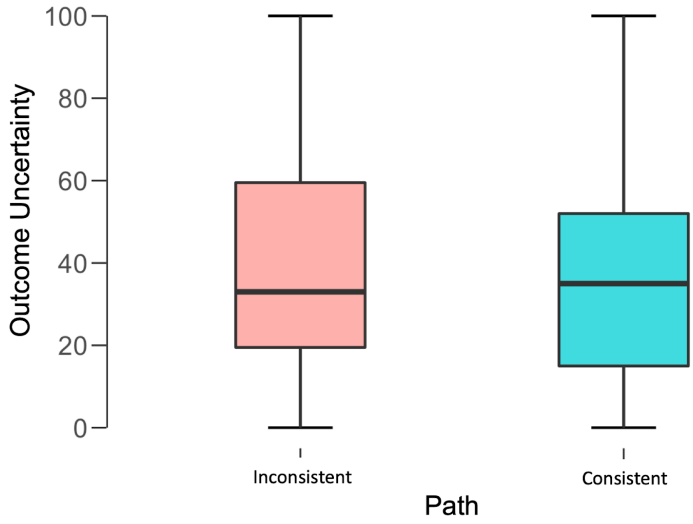

Fig. 25. *Outcome uncertainty* players felt when their decisions were consistent with the outcome versus when they were inconsistent

	Inconsistent		Consistent		W	*p*	r_{rb}
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact	55.03	24.26	60.89	25.15	1245.5	0.20	-0.14
Freedom of Choice	67.39	26.51	70.22	27.49	1368.5	0.60	-0.05
Decision Uncertainty	66.27	21.76	66.80	23.68	1378	0.64	-0.05
Outcome Uncertainty	41.67	27.67	36.31	26.90	1608.5	0.34	0.10

Table 8. Summary descriptive statistics of *impact*, *freedom of choice, decision uncertainty* and *outcome uncertainty* people felt in when their choices were Consistent and Inconsistent with the outcome

Discussion

The study is an important first investigation in games proving that *equivoque* is a viable technique to create illusory choices. It proves that players feel motivating uncertainty when they encounter an *equivoque* choice in a game

which is actually no choice at all (behind the curtains) but an illusion of choice. It shows that a fake choice is better than no choice at all in terms of the dependent variables we considered.

Furthermore, the study proves that players felt similarly whether the outcome was consistent to the choice or not. If these were real choices, the outcomes in line or consistent with the option they picked is more or less how a real choice would work. In contrast, the inconsistent paths twist the outcome. That said, this study is limited to simply testing if *equivoque* creates a motivating *decision uncertainty* in comparison to no choice at all.

The results support our hypothesis and increase our confidence in *equivoque*. However, it is important to note that even when players had no choice there was a reasonable variance in ratings for *impact* and *freedom of choice* measures. That is, the ratings for *impact*, *freedom of choice* aren't completely nil or close to nil. This may have to do with at least two things: (1) the nature of engrossing narratives where people feel they have a sense of agency even when they are just clicking the "Next" button for story progression. (2) As also seen in the lab study, the phrasing and scale of 0-100 of the measures used might be responsible for the range.

From the results we also see that *outcome uncertainty* did not change between the two conditions. We suspect this is because players are engaged in the storyline and are curious about the outcome even if they didn't partake in the decision making process.

While *equivoque* works for narrative choices in a game context, this study is not yet generalisable beyond a small interactive fiction game or storylet. Moreover, this study only looks at a single instance of *equivoque* because of which players might not have noticed the trick. A game would generally have multiple choices and the usage of *equivoque* in narrative games would be further validated if we can see the principle works over and over.

Study 3: Does Equivoque Work if Repeated?

This study was designed to answer the research question: Is *equivoque* viable even when the technique is repeated or can the players see through the trickery? In other words, do players catch on if *equivoque* is repeated in consecutive narrative choices in a game context? Each *equivoque* is not identical in the story but follows the same principle technique of setting up an ambiguous choice and manipulating the inference.

The main thing we want to test is that even if the whole structure with multiple choices is linear i.e. each choice converges to a single node, does the player perceive it differently (in terms of *decision uncertainty* and *sense of agency*)overall than if the choices led to different branches? Do players see through the trickery and lose the motivation to make decisions by the fourth choice if all choices are fake in comparison to when all of the choices are real? Is that any different if real and fake choices are interwoven? To test this: we compare (a) a game with all fake choices with (b) a game with all real choices. We also compare them with conditions where the choices are interleaved i.e. alternated between fake and real in different orders, (c) fake-real-fake-real and (d) real-fake-real-fake. Following the previous study, we measure the success of *equivoque* by recording *impact*, *freedom of choice* and *decision uncertainty*. We dropped the dependent variable of *outcome uncertainty*. This is because so far we have not seen any significant change in it even if the player had no choice. We suspect that players are narratively curious about the story progression regardless of choices. Since we continue the same storyline for this study we did not expect the experiment set up to tell us anything new.

Hypotheses

In this study we collect overall experience data and data with respect to each choice. Looking at the robustness of *equivoque* in card magic we hypothesised that:

H1: On the whole, at the end of the game people will feel similar overall (a) *impact*, (b) *freedom of choice*, and (c) *decision uncertainty* in all four conditions.

The last of four choices would be the most likely one where people would catch or by when they would have caught the *equivoque*, especially in the condition with all four fake choices. This is why we compare the fourth choice across all conditions. However, we do not expect the *equivoque* to fail:

H2: People will feel similar (a) *impact*, (b) *freedom of choice*, (c) *decision uncertainty* on encountering the fourth choice in all conditions.

We also compute the difference between how people felt about their first choice and their fourth choice within each condition. We don't expect *equivoque* to become apparent over the four choices, thus we hypothesised that:

H3: The difference in player's ratings of (a) *impact*, (b) *freedom of choice*, and (c) *decision uncertainty* for the first choice and the fourth choice is not significantly different across the four conditions.

Method

Participants

We ran an a priori power analysis with a power of 0.80, α=0.05, and a moderate effect size of 0.5 (based on the previous study) using GPOWER (Erdfelder et al., 1996). The output was a sample size of 200 participants. We recruited 212 participants of which 12 participants did not pass the attention checks (listed in the Materials section). Data of those participants was discarded. 200 people participated in the end. The average age of the participants was 27 (sd = 7.7), with the youngest player being in the age group of 18 to 25 and the oldest from the age bracket of 45 or older.

Participants were recruited from an ethnically diverse participant pool as long as they were fluent in English. Being a gamer was not part of the requirement especially because the playtests were done on both gamers and non-gamers without seeing much of an effect. Participants were considered only if they could use a laptop or desktop to avoid the experience change on mobile where the text needs more scrolling and can seem longer.

Participants were recruited online with attention checks in place. The reason for recruiting online was to have more ecological validity (players could play in their own natural environment using their equipment how they would play any other browser game except for their knowledge that this is a research work and them having to answer the questions at the end) and make sure participants do not answer questionnaires under any pressure.

Material

The Game

For the study, we expanded the same adventure narrative game *Osaka.* The game could still be played on any browser on a laptop or desktop. The narrative started off with the same set up where the player plays as a young tourist who is visiting Osaka and knows very little about the city. She enters a tricky position when her friend Caron who was going to be her host abandons her. The game poses a question when the protagonist meets her friend for dinner and things start getting risky. Up until the first choice, the game is identical to the one used in Study 2, thereafter, the situation escalates and the player has to make decisions in sensitive situations. All four conditions of the game pose four choices for the players. The story is given

enough depth that people start to care about the choice and all the choices are designed and playtested to be equally balanced to minimise any (unforeseeable) narrative bias. The game could be played in 6 to 10 minutes. The play session was kept between 2 to 10 minutes to mimic average play sessions of games studied in Chapter 5.

Game Design

We created the story by iterating and playtesting all the conditions. The main thing to be tested were: (1) all options are equally balanced (2) the story is engrossing until the end and doesn't get tiring to read. The game had several iterations play-tested by 7 players recruited via social networks.

All four conditions followed the same story but had different branches based on the nature of the choices (fake or real). We tested each condition with players and asked two main questions:

(1) Do you feel all the choices were equally balanced? The reason to ask this question was to check for any narrative bias.

(2) Do you remember the choices you made and why? Since players were going to be asked questions after they had played the game, we wanted to make sure that they could actually remember their decisions to answer as accurately as they could.

We iterated on all four game conditions until our players reported that they felt all the options were fairly balanced and that they remember their decisions and the reasoning behind those decisions.

> "*Do you think all the options were equally hard/easy to answer*" [Interviewer]
> "*Yes… When evaluating a situation there were pros and cons and there was no clear good choice, so I made what I thought was good if I were in that situation*"[p5]
>
> "*When you were asked to rate each decision, did you remember what you were being asked*?" [Interviewer]
> "*Yeah. I had read the text well*" [p7]
> "*It was not too long to forget*" [p8]

We rephrased the question if needed:

> "*So there were 4 choices, do you think they were equally demanding*" [Interviewer]

"*Yes. All of them seemed to be a matter of choosing a "safe" option for ensuring survival*" [p6]

Game Conditions

The experiment was set up as a between participant study between 4 groups to test if *equivoque* can work when repeated. In the first condition, players were given four consecutive choices, all of which were fake (or were *equivoques*). In the second condition, players were given four consecutive choices, all of which were real. In the third condition, players were given four consecutive choices, in the order of fake, real, fake and real. In the fourth condition, players were given four consecutive choices, in the order of real, fake, real and fake. As designed in Study 2, all choices had two options and the fake choice had the same outcome no matter which option was picked. The two options in the fake choices were: one option took them to the outcome consistent with their choice and the other had an inconsistent outcome.

The reason we chose these four conditions is because we wanted to test if repeating fake choices with one starting node and one ending node has the same effect (in terms of our dependent variables) as repeating real choices with many more branches. Additionally, we wanted to check if alternating fake with real choices, ending in a real choice or ending in a fake choice makes the trick more (or less) apparent.

Condition All Fake:

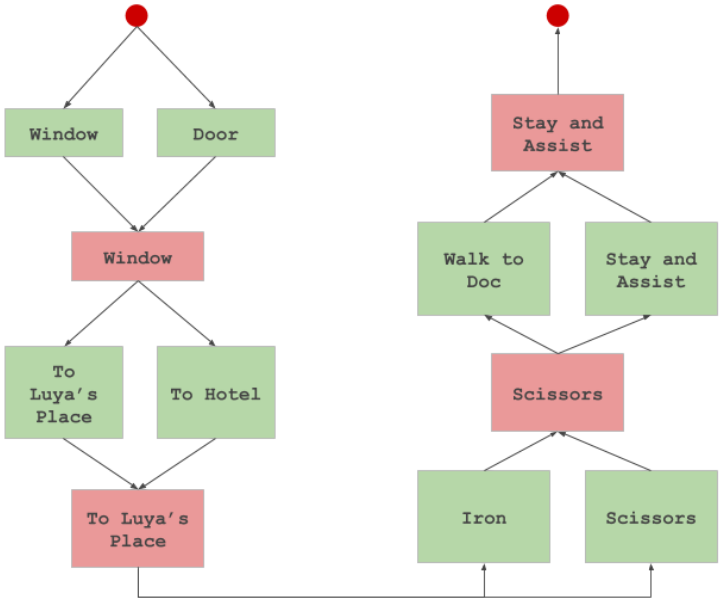

Fig. 26. Condition All Fake flow. Green boxes are the choices, red boxes are the outcomes.

As in Study 2, the player is given a choice to go through the *window* or the *door* but is made to go through the *window* anyhow.

Sample Story Snippet- Choice#1

> "Gosh, we should hurry" she cuts you off, "which way?"
>
> - Front Door
> - Window

As decided in the story, Caron and the protagonist meet at the corner shop where Caron is mostly busy on her phone and then tells the player about her friend Luya and how going to her place could be safer. The player is given a choice to either go to *Luya's place* or go back to *the hotel.*

Sample Story Snippet- Choice#2

> "The hotel seems calmer... but I don't think your stuff is safe there. My friend Luya may be able to rent you a room for the night. You could also probably get your things."
>
> - To Luya's Place
> - To Hotel

No matter what the player chooses, they are taken to *Luya's place*. At Luya's the player finds Luya injured and unconscious and Caron hiding behind a door. The player joins her where she asks the player to keep shush and points at a sewing table which poses a choice of an *Iron* or *Scissors.*

Sample Story Snippet- - Choice#3

> She looks at you and points at the table. There is a pair of scissors and an iron there. She points at it more intently, you assume she is asking.
>
> - Scissors
> - Iron

No matter what the player picks, they get the *Scissors.* The plan was to attack or pose an attack using these tools, however Luya shouts for them in pain, Caron and the protagonist see that they have no way to phone call for help.

This is when Caron asks the player to make a decision to *stay and assist Luya* or to *go and get the doctor*.

Sample Story Snippet- - Choice#4

> "We got to split and take care of Luya, there is a doctor nearby."
>
> - Walk down to the Doctor's
> - Stay and assist Luya

Irrespective of the decision made by the player, the player stays with Luya and Caron goes to get the doctor.

Condition All Real:

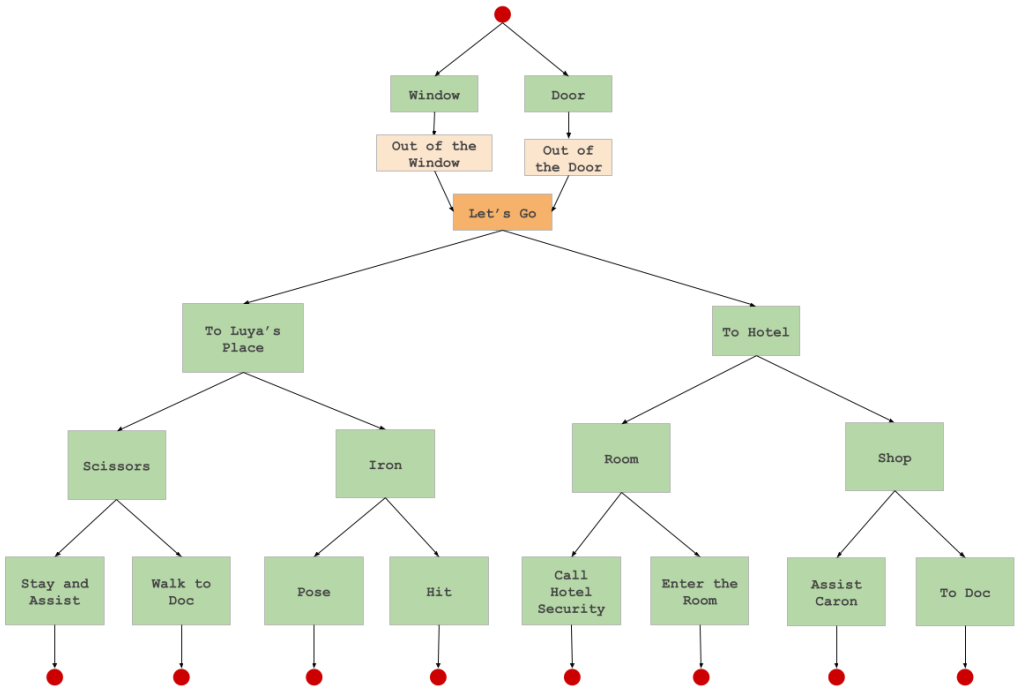

Fig. 27. Condition All Real flow. Green boxes are the choices, light orange boxes are the unique outcomes.

Condition All Real starts with the same story where the player is given a choice to go through the *window* or the *front door* but since the choice is real they actually exit through the route of their choice. The protagonist meets Caron at the corner shop where she is mostly busy on her phone and then tells the player about her friend Luya and how going to her place could be safer. The player is given a choice to either go to *Luya's place* or go back *to the hotel*. If the player chooses to go to Luya's, they go there to find Luya injured and unconscious and Caron hiding behind a door. The player joins her where she asks the player to keep shush and points at a sewing table which poses a choice to hand Caron an *Iron* or *Scissors.* If the player chooses *Iron,* Caron explains the plan of distracting the attacker by posing.

Sample Story Snippet

"When they barge in. One of us could distract them by posing and the other could hit"

- Pose
- Attack

If the player chooses to *Pose,* they are happy that they are not the one doing the attacking and if they had chosen to *Attack,* they are happy to know that they are the one in control. [Game ends with a unique resolution for each choice]

Had the player chosen to hand over *Scissors* to Caron in the third choice, the plan to attack or pose an attack using these tools would be mid way when Luya would shout for them in pain. Caron and the protagonist see that they have no way to phone call for help. This is when Caron asks the player to make a decision to *stay and assist Luya* or to *go and get the doctor*. [Game ends with a unique resolution for each choice]

However, had the player chosen to go to the hotel when she met Caron around the corner (in the second branch) they would feel a sense of relief but would see a frantic Luya at the hotel reception looking for Caron. The protagonist would tell her that they just left her at the corner but she would insist that Caron said she was in the protagonist's room before she became unreachable on the phone. The protagonist is a bit annoyed but Luya seems sweet and she begs for their help and says that they both should look for Caron. The player is given the choice to look into their *room* or go to *the shop.*

Sample Story Snippet

> Luya insists that Caron could be in your room, "One of us should check the room or go look at the shop you mention"
>
> - Room
> - Shop

If the player chooses to go to the *Room*, they meet Caron there who tries to pull the protagonist in. The protagonist gets angry and asserts themselves. They are given two choices, to *call the hotel security* or *enter the room* and confront Caron. [Game ends with a unique resolution for each choice].

Sample Story Snippet

> "How did you get in Caron ?!!", you are angry.
> "Oh come on - come in first"
>
> - Call hotel reception for security
> - Enter the room

Had the player chosen *Shop,* they would have found Caron injured and barely conscious. Luya would join them and they would decide to split. The player would be given a choice to *stay and assist Caron* or *to go get a doctor.* [Game ends with a unique resolution for each choice].

Condition Fake Real Fake Real:

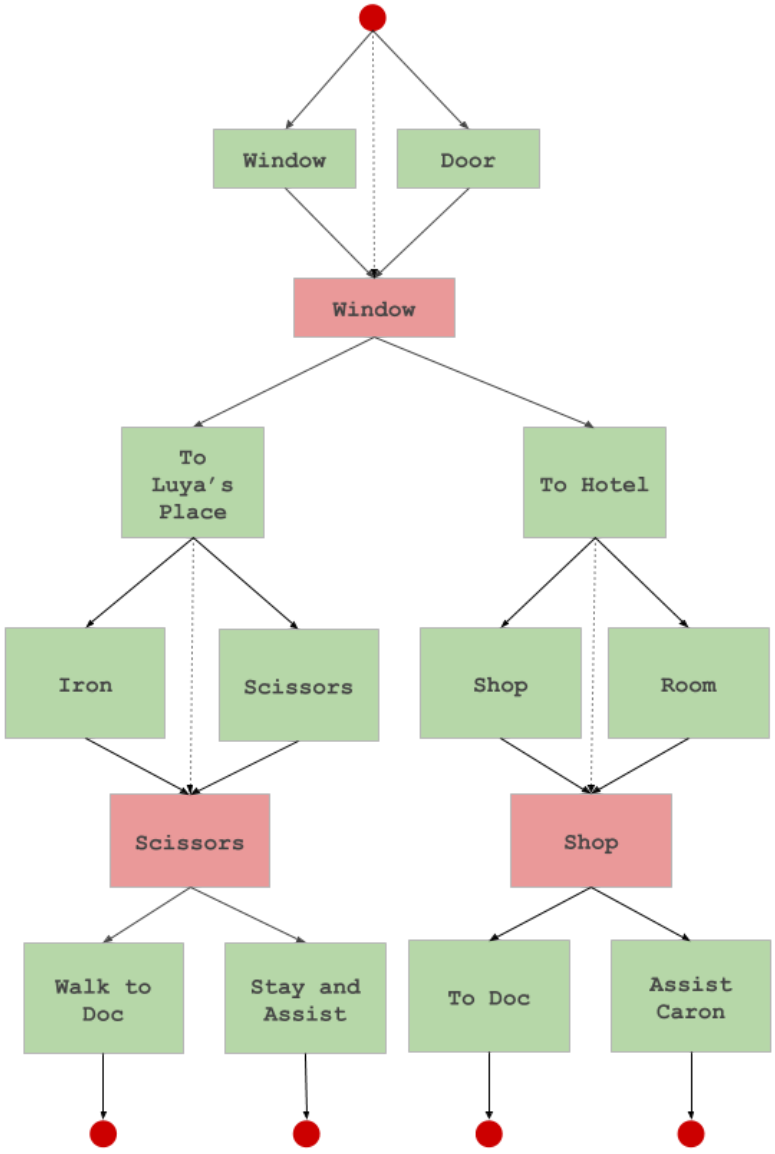

Fig. 28. Condition Fake Real Fake Real flow. Green boxes are the choices, red boxes are the outcomes

Condition Fake Real Fake Real follows a mix of the storyline in Condition All Fake and Condition All Real where the player alternates between a fake choice and a real choice starting with a fake choice and ending with a real choice. The first choice is fake, no matter what the player chooses they are made to exit the hotel room using the *window*. The second choice, of going to

Luya's place or the *hotel* is real, branching in the same way as in Condition All Real. If the player chooses to go to Luya's, they are confronted with the same choice of *Iron* or *Scissors,* this is a fake choice where irrespective of the player's choice, they are given the scissors after which Luya shouts for help and the player is posed with a real choice to *stay and assist Luya* or to *go to the doc*. [Game ends with a unique resolution for each choice]. However, had the player chosen to go to the hotel when she met Caron around the corner (in the second branch), it would follow the same story as Condition All Real and the player would face a fake choice of going to the *shop* or their *room,* where their decision would be forced as the *shop.* At the shop, they would see Caron injured and will be posed with a real choice of *assisting her* or *going to get the doctor*. [Game ends with a unique resolution for each choice]

Condition Real Fake Real Fake:

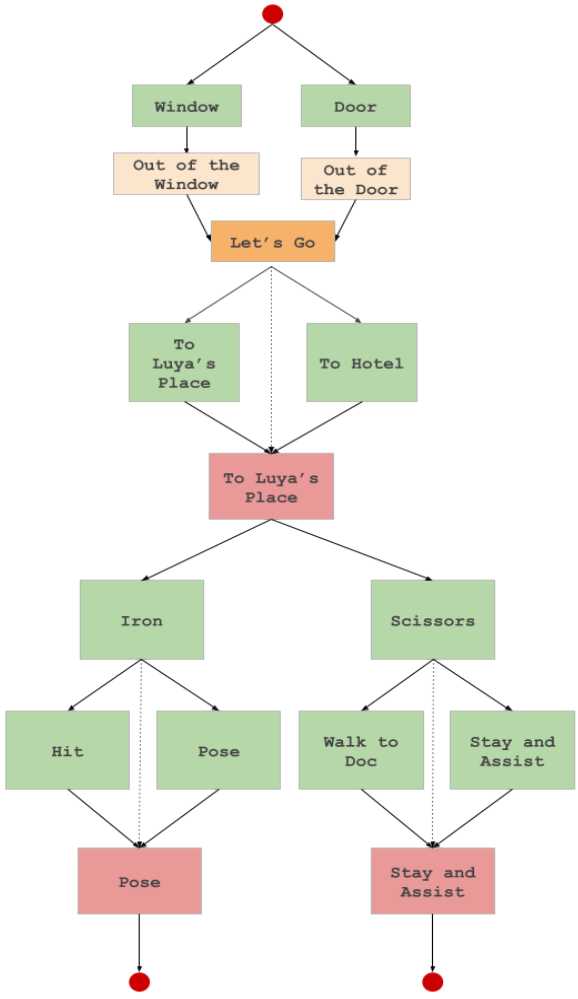

Fig. 29. Condition Real Fake Real Fake flow. Green boxes are the choices, red boxes are the outcomes

The storyline is a subset of previous conditions. The player alternates between a fake choice and a real choice starting with a real choice and ending with a fake choice. In the beginning, the player gets a real choice between *front door* and *window,* and Caron and the protagonist meet at the corner shop. There, the choice to go to *Luya's place* or the *hotel* is a fake one, where no matter what the player chooses, they go to Luya's, where Caron is hiding behind the door and gives a legit choice to the protagonist by pointing at the sewing table, to hand her the *iron* or the *scissors.* If the player chooses *iron,* they are given a fake option to *attack* or to *pose* each leading to the same conclusion of posing. On the other hand, had the play chosen *scissors,* they are called by Luya in a dire state and are faced with the fake choice to *stay and assist* her or to *go to the doctor,* each choice leading to the same conclusion of the protagonist having to stay with Luya.

Attention and Comprehension Checks

Same as Study 2, we added attention and comprehension checks to make sure players actually read the text and were not distracted during the task. Additionally, since the study was conducted via *Prolific*, we wanted to cross check that the players were fluent in English (the language in which the story was told):

1) The game had multiple story screens, we recorded how much time players spent on each screen to check if they spent at least 40 seconds per screen. Their data was discarded if they spent less time than that on any of the story screens.

2) Players were asked to answer a story related question (see below) in their own words. This would tell us if they understood the context of the story and also verify that they are fluent in the language. People who left this box empty or answered unreadable gibberish were not considered for the data.

3) Only the players who finished the task within the range of 5 to 17 minutes were considered to make sure that they were not distracted or left the browser for too long, if at all. Their data was discarded if they took more time to finish the task.

Procedure

The study was a between participant design, where four different groups of participants played the four different conditions (see above). Participants were given an information sheet and asked for their consent and demographic details (age, gender). Participants were informed about their

rights to withdraw. Players would then play the game. At the end of the game session they were asked to answer a few questions. Players were not allowed to play again.

Measures

We asked sixteen questions in all. Of the sixteen, three questions captured the player's overall experience of the game which they answered using a sliding scale (0 - 100). They also answered one open question to get a deeper understanding of their rating and as a comprehension check.

(1) *Overall freedom of choice*: How free did you feel to pick your options? Not free (0) to Very free (100)
(2) *Overall impact*: How much impact did you feel your choices had on the outcome? No impact (0) to Very high impact (100)
(3) *Overall Decision Uncertainty*: Did you weigh alternatives to make decisions? No at all (0) to A lot (100)
(4) Please explain your rating on the above question (Did you weigh alternatives to make decisions?) in a few words

Below three questions were repeated for each of the four choices to check how players felt about each of their decisions. Players were asked to rate all three dependent variable with respect to their corresponding choices using the same rating system:

(1) How free did you feel to pick your option [player's choice]?
(2) How much impact did you feel your choice [player's choice] had on the outcome?
(3) Did you weigh alternatives to make the decision [player's choice]?

Results

51 participants played the Condition All Fake, 50 participants played the Condition All Real, 51 participants played the Condition Fake Real Fake Real and 48 participants played Condition Real Fake Real Fake.

Overall Impact

As expected in H1(a), the *overall impact* players feel their choices had on the outcome does not significantly change between the four conditions (see Fig. 30). This was demonstrated using a Kruskal-Wallis test ($X^2(3,200) = 0.92$, $p = 0.819$, $\eta^2 = 0.004$).

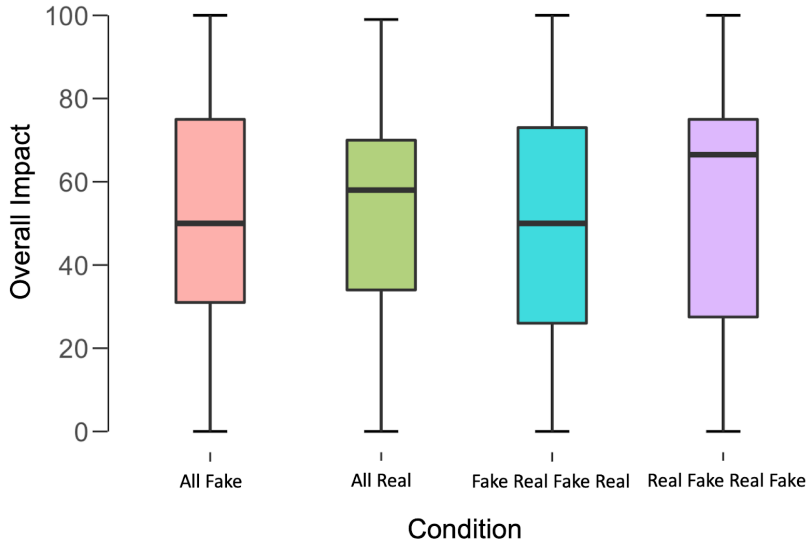

Fig. 30. Players' overall perception of *impact* across all four conditions

Overall Freedom of Choice

As expected H1(b), the *overall freedom of choice* players feel their choices had on the outcome does not significantly change between the four conditions (see Fig. 31). This was demonstrated using a Kruskal-Wallis test ($X^2(3,200) = 1.41$, $p = 0.70$, $\eta^2 = 0.007$).

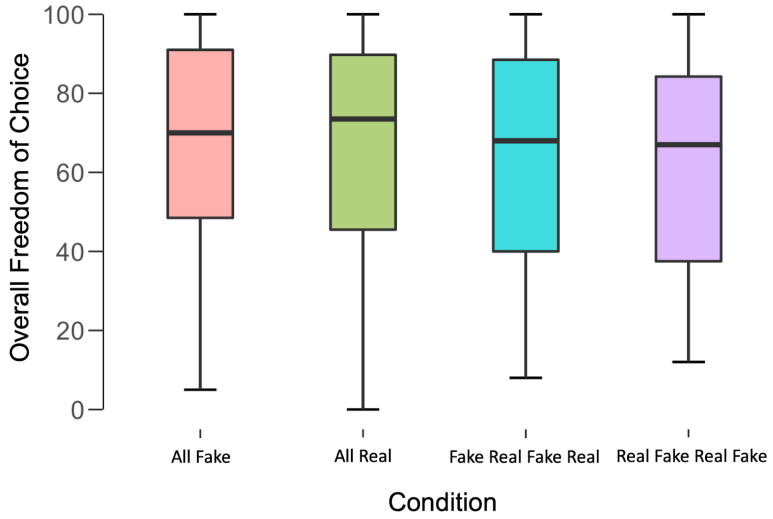

Fig. 31. Players' overall perception of *freedom of choice* across all four conditions

Overall Decision Uncertainty

A Kruskal-Wallis test across the four conditions contradicted our hypothesis H1(c). It showed that the *overall Decision Uncertainty* players felt while making their decisions changes significantly between the four conditions

($X^2(3,200) = 11.05$, $p = 0.011^*$, $\eta^2 = 0.047$). A deviation contrast analysis showed that Condition All Real made participants feel significantly less uncertain for their choice ($t(196) = -2.30$, $p = 0.022^*$). This was surprising to us considering that the condition with all real choices illustrates genuine decisions.

We conducted a post hoc Tukey analysis to compare Condition All Real with the rest of the three conditions. None of the conditions when compared individually to each other show a significant difference. However, the variation was more pronounced when Condition All Real was compared with Condition Real-Fake-Real-Fake and Condition Fake-Real-Fake-Real (see appendix C). The main comparison (Condition All Fake vs. Condition All Real) that is most interesting to us is far from any significant difference ($t(198) = 0.67$, $p = 0.908$, $d = 0.12$). This shows that people felt similar *decision uncertainty* whether all choices were fake or real.

Condition All Real compared to Condition Fake Real Fake Real does not show significant difference ($t(198) = -2.519$, $p = 0.06$, $d = -0.56$). Similarly, Condition All Real compared to Condition Real Fake Real Fake does not show significant difference ($t(198) = -2.45$, $p = 0.07$, $d = -0.50$). However, noticeably they have a larger difference of means between them and warrant a closer look in future studies.

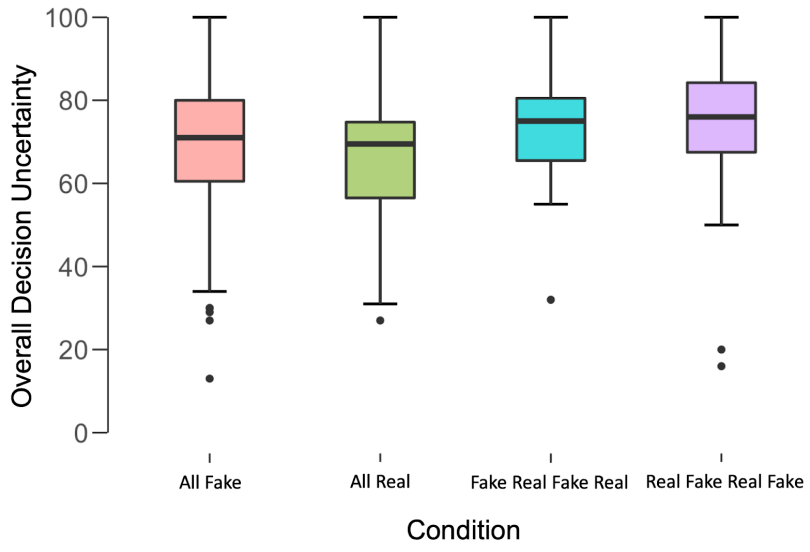

Fig. 32. *Overall decision uncertainty* players felt across all four conditions

	All Fake		All Real		Fake-Real-Fake-Real		Real-Fake-Real-Fake		X^2 (3,200)	*p*	η^2
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*			
Overall Impact	50.84	28.58	50.66	25.80	49.58	27.33	53.97	27.13	0.92	0.82	0.004
Overall Freedom of Choice	66.90	27.71	68.34	26.89	63.94	27.82	62.34	28.21	1.41	0.70	0.007
Overall Decision Uncertainty	68.94	20.62	66.64	16.82	75.29	13.63	75.20	17.25	11.05	0.01*	0.047

Table 9. Summary descriptive statistics for *overall impact*, *freedom of choice* and *decision uncertainty* players felt across all four conditions

Impact: Fourth Decision

As expected in H2(a), the *impact* participants felt their last choice had on the outcome does not significantly change between the four conditions (see Fig. 33). This was demonstrated using a Kruskal-Wallis test ($X^2(3,200) = 2.10$, $p = 0.55$, $\eta^2 = 0.013$).

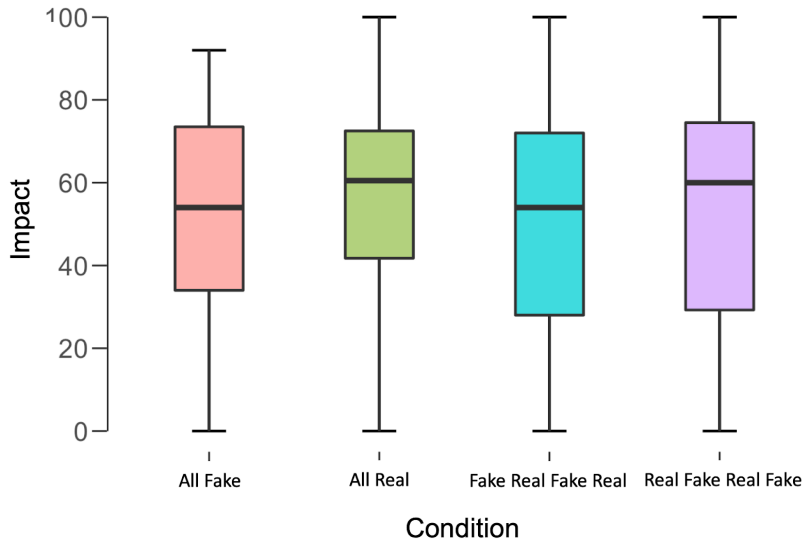

Fig. 33. *Impact* players felt their final choice had on the outcome across all four conditions

Freedom of Choice: Fourth Decision

As expected in H2(b), the *freedom of choice* participants felt they had in making their last choice does not significantly change between the four conditions. This was demonstrated using a Kruskal-Wallis test ($X^2(3,200) = 1.76$, $p = 0.62$, $\eta^2 = 0.008$).

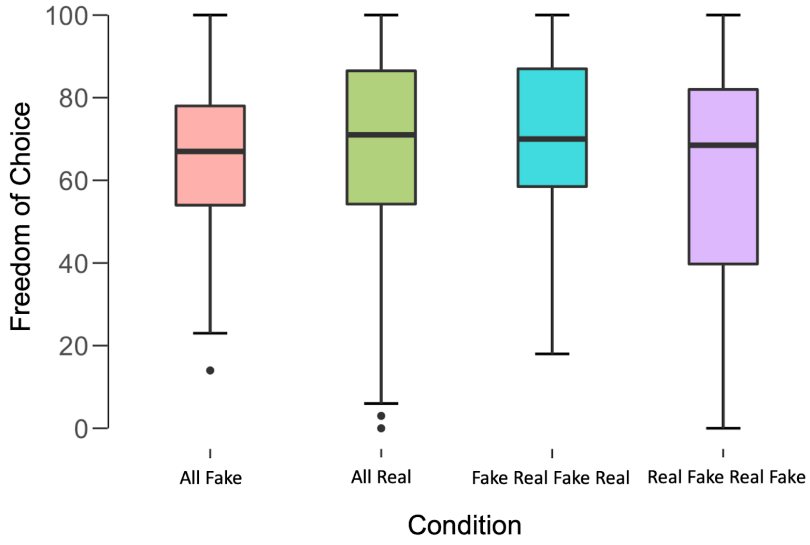

Fig. 34. *Freedom of choice* players felt in making their final choice across all four conditions

Decision Uncertainty: Fourth Decision

As expected in H2(c), the *Decision Uncertainty* participants felt while making their last choice does not significantly change between the four conditions (see Fig. 35). This was demonstrated using a Kruskal-Wallis test ($X^2(3,200) = 7.45$, $p = 0.059$, $\eta^2 = 0.03$). Since p value was closer to significance we did a post hoc analysis for adjacent comparison of each condition with the other and did not find any significant results (see appendix C).

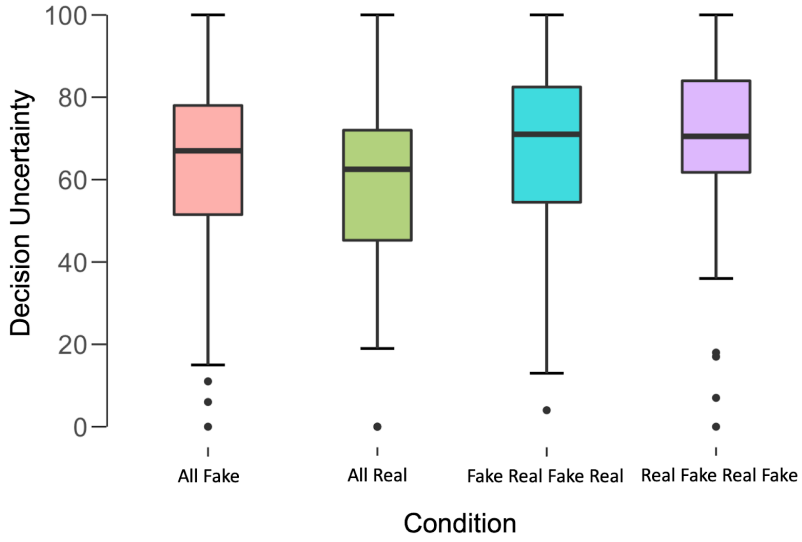

Fig. 35. *Decision uncertainty* players felt in making their final choice across all four conditions

	All Fake		All Real		Fake-Real-Fake-Real		Real-Fake-Real-Fake		X^2 (3,200)	*p*	η^2
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact	52.15	24.39	58.56	24.70	50.70	25.74	52.60	29.19	2.10	0.55	0.013
Freedom of Choice	64.92	21.26	67.66	26.45	68.19	24.14	62.64	25.90	1.76	0.62	0.008
Decision Uncertainty	61.45	23.57	59.08	23.13	66.21	23.44	69.67	23.70	7.45	0.06	0.03

Table 10. Summary descriptive statistics for *impact, freedom of choice* and *decision uncertainty* players felt for their fourth choice across all four conditions

Lastly, we see whether the consecutive fake choices make the dependent variables drop from first to fourth choice more in Condition All Fake compared to other conditions and also to see the variation between the other conditions.

Impact Difference between First and Fourth Choice

As expected in H3(a), the difference in *impact* players felt their first choice and fourth choice had on the outcome does not significantly change across the four game conditions. This was demonstrated by a Kruskal-Wallis test ($X^2(3,200) = 4.43$, $p = 0.22$, $\eta^2 = 0.020$).

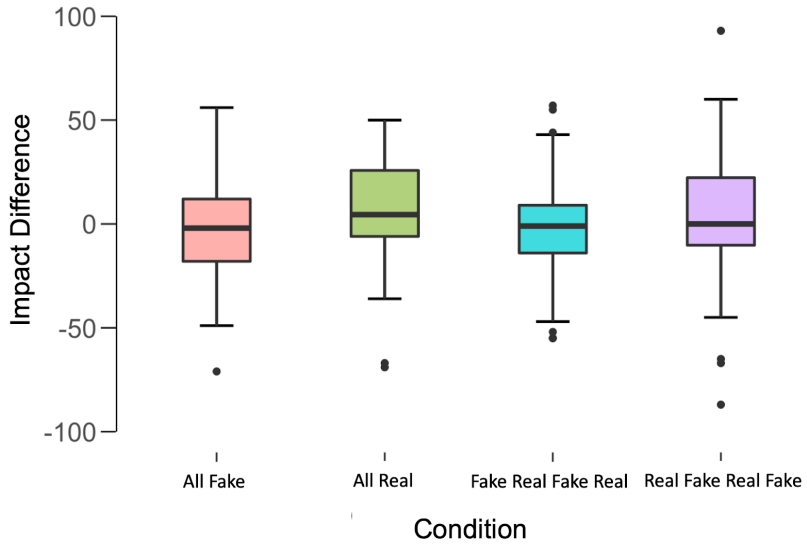

Fig. 36. Difference in *impact* players felt in making their first and final choice across all four conditions

Freedom of Choice Difference between First and Fourth Choice

As expected in H3(b), the difference in *freedom of choice* players felt in making their first choice and fourth choice does not significantly change across the four game conditions. This was demonstrated by a Kruskal-Wallis test ($X^2(3,200) = 0.94$, $p = 0.815$, $\eta^2 = 0.007$).

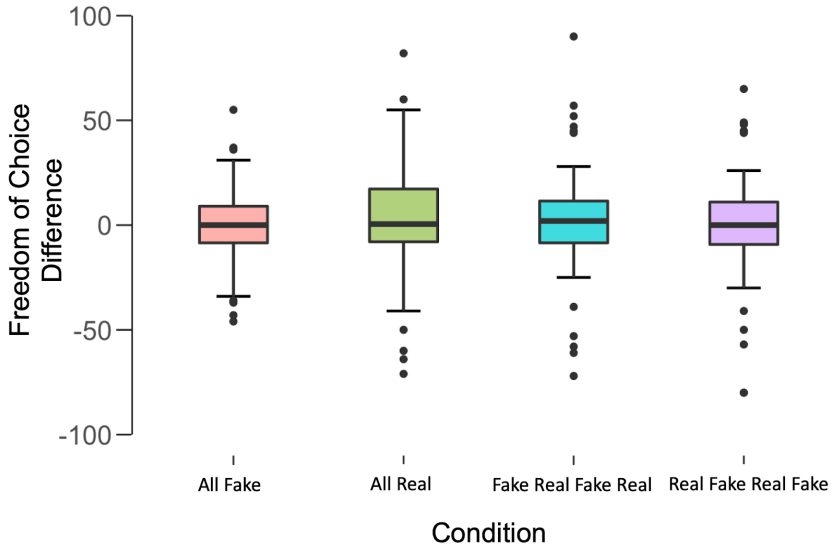

Fig. 37. Difference in *freedom of choice* players felt in making their first and final choice across all four conditions

Decision Uncertainty Difference between First and Fourth Choice

As expected in H3(c), the difference in *Decision Uncertainty* players felt in making the decision for their first choice and fourth choice does not significantly change across the four game conditions. This was demonstrated by a Kruskal-Wallis test ($X^2(3,200) = 0.27$, $p = 0.965$, $\eta^2 = 0.006$).

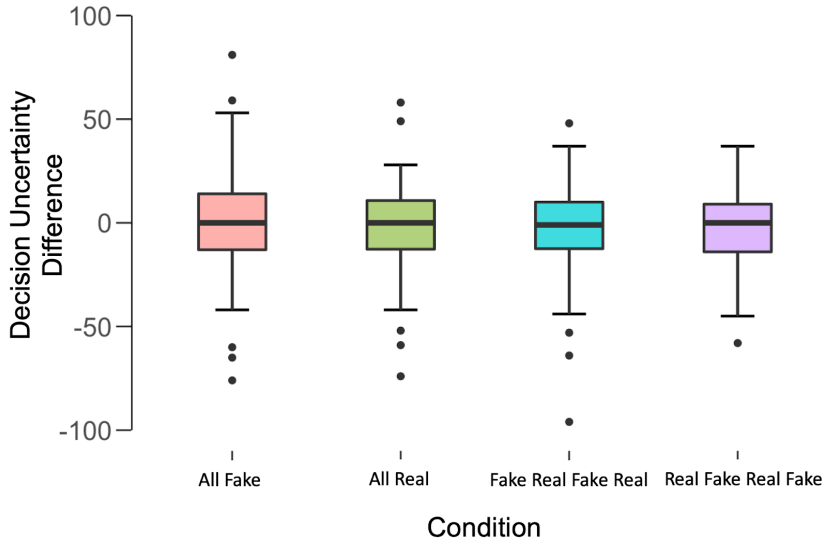

Fig. 38. Difference in *decision uncertainty* players felt in making their first and final choice across all four conditions

	All Fake		All Real		Fake-Real-Fake-Real		Real-Fake-Real-Fake		X^2 (3,200)	*p*	η^2
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*			
Impact Difference	-3.37	25.79	5.62	26.64	-3.15	26.92	3.39	33.72	4.43	0.22	0.020
Freedom of Choice Difference	-1.23	20.20	4.28	31.98	2.09	29.05	-1.33	29.07	0.94	0.81	0.007
Decision Uncertainty Difference	0.72	28.84	-3.44	24.49	-4.21	25.22	-2.95	19.83	0.27	0.96	0.006

Table 11. Summary descriptive statistics for difference in *impact*, *freedom of choice* and *decision uncertainty* players felt for their first and final choice across all four conditions

Discussion

The study investigated if people perceive the illusion of choice provided by *equivoque* as real in terms of *decision uncertainty*, *impact* and *freedom of choice* even when it is repeated four times. It proves that *equivoque* is effective even when repeated. Players feel a similar sense of *impact*, *freedom of choice*, and *decision uncertainty* throughout the four choices regardless of whether the choices are all real or all fake. We also show that interleaving fake choices with real choices does not diminish the perceived *impact* and *freedom of choice*, irrespective of the order of the alternation. We do see lower (non-significant) *overall decision uncertainty* in Condition All Real compared to the two interleaved conditions. We suspect this is because of the

subjective nature of the narrative. As such, minor deviations are to be expected. We should look closely into the interleaved conditions to see if illusory choices should be better integrated with real ones.

For the fourth choice, when the *equivoque* has already been repeated four times, players don't show any significant difference in experience if they faced four real choices, four fake choices or interleaved. We also showcase that there is no significant difference in the difference in *impact*, *freedom of choice*, *Decision Uncertainty* players felt when they made their first choice and fourth choice. We don't see *equivoque* to become apparent over the course of the narrative.

In hindsight maybe the study could have been designed only with two conditions: Condition All Real and Condition All Fake to establish they provide similar experiences. The reason for this insight is rethinking the clarity of the goal of this study to provide initial proof to show *equivoque* can work in game narratives even over consecutively repeated choices.

Overall Discussion and Conclusion

Overall the studies prove that *equivoque* works, even when used repeatedly. We pave the path of transferring the stage magic principle of *equivoque* to narrative games at a level of short interactive fiction and we hope to apply this further in future. We do this by first establishing *equivoque* in its stage magic form with playing cards. The transferred technique is tested against the same measures with additional uncertainty measures that we are interested in. We find that using playtesting and iterating on game design for a study in a research setup helps in transfer of design principles. We couldn't simply lift phrases used by magicians (e.g. pick one for me), we needed to find an instantiation of the principle that works for a concrete game situation.

The main takeaway from the studies is that players feel as if they have a real choice even if the outcome is predetermined. This makes them feel in control of the choice, free in making the choice and makes them ponder over their decisions. In all, it can be concluded that an *equivoque* illusory choice can elicit *decision uncertainty* as a real choice would in game narratives and from the player's perspective is simply a (real) choice. We did find a considerable amount of outliers in the studies and it could be because the outlying participant's treated the 0-100 scales as binary and gravitated towards the extremes. For future work, it might be worthwhile to consider creating a measurement scale for m2m motivating uncertainty to avoid these issues.

Lastly, we acknowledge that the results are not yet generalisable but provide a good first proof to continue work in this direction.

Chapter 8

Discussion and Conclusion

Our primary research question behind this thesis was:

> *What is the role of uncertainty in moment-to-moment player motivation? How can we design for such uncertainty?*

While uncertainty has been pointed out as a key gameplay experience, there was little understanding of why this experience is motivating for players, especially at a m2m gameplay level. We articulated this question in response to underwhelming research in games with respect to motivating uncertainty and epistemic emotions. We especially noticed a lack of work that offers practical insights for design purposes. To answer the second part of the question – '*how can we design for such uncertainty?*' – we quickly realised the need to look for inspiration elsewhere and devised a more specific follow-up question:

> *Can the magic forcing principle of equivoque offer design inspiration for evoking motivating decision uncertainty in players?*

Research Contributions

Due to the multifaceted nature of the research question, a number of research objectives were sketched out to resolve it. We present each objective and the connected contributions made.

Research Question 1

> *What is the role of uncertainty in moment-to-moment player motivation? How can we design for such uncertainty?*

To answer this question, we articulated the following three research objectives.

Research Objective 1

To examine the current player motivation tapestry in order to position uncertainty and related epistemic emotions.

Findings and Discussion

Our literature review found a surfeit of play(er) categorisations that divide them based on features or stable behavioral traits, not situational internal states. None of the five major typologies we reviewed engaged directly with curiosity or the broader psychological literature on epistemic emotions. Notable ones, like Caillois' (2001), Bartle's (1996), Yee's (2016), and Hunicke et al's (2004) classify play forms that can be connected to epistemic emotions and uncertainty, but don't make this link explicit: alea/games of chance, exploration, discovery. Lazzaro (2004) is a partial exception, mapping curiosity onto "Easy Fun," as is recent work by Csikszentmihalyi and others linking challenge/skill balance to suspense (Abuhamdeh et al., 2015) , but beyond that, we do not see epistemic emotions studied in player experience or player typologies in much detail, especially as states or from a design perspective. We contribute to the literature by illustrating this important gap and doing the initial work of filling it.

We unpack player motivation research expanded from early typologies by importing concepts from psychology, like needs (SDT), flow, habits, goals and plans, emotions, and more recently, eudaimonic experiences. Across this literature, again, our main finding is that epistemic emotions that players experience have not been looked empirically into with respect to player motivation. Even where these are touched on, for example in Lazzro's work (2004), they are not explored at the micro level of m2m motivation or design features that evoke them. Thus, our first contribution is demonstrating that curiosity and epistemic emotions have not been systematically investigated in player motivation studies, especially in terms of motivating m2m gameplay that is so important to game designers.

To counter this shortcoming, we then reviewed the psychological literature to establish the role of curiosity in human motivation. We find that curiosity can be pleasurable and related to interest but also evoked as aversion to a knowledge gap (J. A. Litman, 2008). While such nuanced aspects of curiosity are widely studied and debated upon in human motivation, they are very superficially explored when it comes to games. Furthermore, we find that uncertainty that presents a resolvable information gap is a major 'collative variable' stoking curiosity. With this tight established link, we position uncertainty firmly as a motivational construct, which was otherwise more or less an isolated concept in player experience literature.

Our survey on epistemic emotions finds strong interrelations between curiosity, surprise, uncertainty and interest. Curiosity towards outcomes is

linked to the emotion of surprise; the violation of expectations enables learning and further curiosity (information-seeking); interest and curiosity overlap with a key difference being that interest can not be satiated; furthermore, the literature shows that novelty, challenge, and suspense are all salient for eliciting epistemic emotions.

To our knowledge, our survey is the first to look at curiosity across the player motivation literature – typologies, emotions, needs, uses and gratifications, and eudaimonic experiences. Epistemic emotions are a recognised cluster in motivational psychology and are part of other psychological and philosophical theories: narrative theory (Bal & van Boheemen, 2009), hermeneutics theory (Schmidt, 2016) etc., but not treated as such (a recognised cluster of player emotions) nor adopted and tested independently in games research with respect to their relationship with other player emotions and experiences. We also find that while uncertainty has been pointed out as a key player experience and/or game feature (Bateman, 2008; Costikyan, 2013; Johnson, 2018; C. Power et al., 2019), it has not been studied in its linkage to other motivations or at a micro level. It is not spoken of as motivational but just as a "characteristic" experience of gameplay. That said, there are theories that shine a light on

Limitations and Future Work

The presented literature review is not a fully systematic one i.e. it did not follow a specifically structured question to guide the review, nor can we say that it is completely unbiased. It didn't go in-depth on adjacent literatures in game-based learning (Loderer et al., 2020) and gamification (Deterding et al., 2011; J. Hamari et al., 2014), or play (Bogost, 2016) or design (D. Norman, 2013) or philosophy (Barthes, 2001) more rigorously. We suggest looking at these adjacent fields as future work.

For future work, it will be valuable to draw links between uncertainty and curiosity, but also other epistemic emotions like suspense and surprise in games. We would recommend analyses of games and game design models and methods developers already informally use to elicit epistemic emotions. We would then recommend testing these methods for generalisability.

We see very little research that has been informed by practitioners in the field of games research, both for building theory and testing used practices. We suggest studies that involve practitioners and players to inform the field's literature. Such observations like we see in Bartle's and Costikyan's work can be a strong basis for conducting more rigorous studies. For future work we

also suggest a review of established models that other creative fields use to elicit epistemic emotions.

Research Objective 2

To explore when and why uncertainty becomes motivating in moment-to-moment gameplay.

Findings and Discussion

We found seven motivating uncertainty types felt by players in games by employing constructive grounded theory (Chapter 4). These types are based on the source of uncertainty and their positioning in the game's core loop, thus explaining *when* during m2m play uncertainty is motivating. Additionally, we found links of these uncertainty types with existing motivational constructs, thus explaining *why* these uncertainty types are motivating for the players.

The seven types of uncertainty are sourced from: *the game*, *the player* and *the outcome*. Players experience (1) *Game uncertainty* in being curious about novel content (*content uncertainty*) and content configurations (*configuration uncertainty*) the game presents to them, which entails setting implicit or explicit new goals. (2) players then experience *player uncertainty* over their own reaction to the game's new material: what decisions to make (*decision uncertainty*), how exactly will/should they execute their chosen actions (*interaction uncertainty*), and whether they are competent enough to perform well (*adaptation uncertainty*). (3) as the players ponder and perform actions, they experience *outcome uncertainty* about what the outcome of their actions would be. They look forward to seeing how their decisions and actions pan out (*result uncertainty*), how good they actually prove to be, how an opponent would react to them (*opponent uncertainty*), and what new content may be unlocked as a result.

Overall, the three main sources of uncertainty work in a tight loop of game prompt, player action, and game reaction. This echoes e.g. gambling research (G. H. Weiss, 1979) finding a link between *decision and outcome uncertainty*, and Johnson (2018), who observes that *game uncertainty* informs player actions. Costikyan (2013) has a concurrent running commentary throughout his book that information gaps in the game (what we call *game uncertainty*) lead to player's uncertainty .

Moving from uncertainty types to the underlying *why*, in mapping players' rationales to existing motivational constructs, we find that curiosity comes

out as a common motivator (the main why) across all uncertainty sources. This falls in line with existing explanations of the relation between uncertainty and curiosity (Litman & Jimerson, 2004; Loewenstein, 1994; To et al., 2016). Our work lends support to these prior claims, while differentiating them with more detailed suggested mechanisms around different kinds of uncertainty sources. This nuanced linkage between uncertainty and curiosity is an important finding considering we know that curiosity is a well established and crucial motivational construct (Berlyne, 1950; Silvia, 2012) also discussed within games (Garris et al., 2002; Lazzaro, 2004). We also tentatively link different uncertainty sources to other corresponding existing motivational constructs, like sense of agency, competence, achievement, mastery, and goal-setting.

Furthermore, our work provides a comparison of existing taxonomies with the one we present. We show that our taxonomy partially maps onto existing taxonomies, especially Costikyan's (2013) eleven sources of uncertainty, providing converging evidence for their validity. We compare our taxonomy with three important contemporary taxonomies of uncertainty are Costikyan (Costikyan, 2013), who classifies uncertainty as a game designer based on sources, Power and colleagues (2019), who develop a scale with different facets of player experience of uncertainty in games (PUGS), and Johnson (2018), who and proposes a theoretical framework categorizing unpredictable game elements. We highlight certain aspects overlooked by existing taxonomies; for instance Costikyan's taxonomy mixes overall uncertainty and m2m level uncertainty often making the categories entangled. He bunches several forms of uncertainty under *narrative anticipation* that, based on our empirical data, are actually separate in the player's experience. For example, his broad category of *narrative anticipation*: the desire to find out how the story or play arc of a game unfolds. It cuts across *game*, *player*, and *outcome uncertainty* in terms of players wanting to see new content and how the game and others respond to their actions. In our work, this was not reported as a collective anticipation by players instead as anticipation around each category of uncertainty described in the model. PUGS (Power et al., 2019) shows little overlap with ours because (a) they descriptively focus any kind of uncertainty, where our model captures engaging uncertainty, (b) they are interested in summative dimensions of overall gameplay, whereas our model disentangles a phenomenal sequence of causes and experiences in m2m gameplay, and (c) their model is limited to assessing structures within items proposed by prior theoretical models, where our model is grounded in open naturalistic observation. Johnson's (2018) nomenclature proposes an analytic distinction of unpredictability according to phases in a game which does not capture any *player uncertainty*.

Overall, while our empirically grounded model supports several prior theoretical categories in existing models, it goes beyond their scope identifying novel uncertainty types like *content*, *adaptation* and *outcome uncertainty*. This arguably advances our ability to guide game designers in affording engaging uncertainty in games. Our investigation (1) presents an uncertainty taxonomy that is grounded in naturalistic observation, corroborating and challenging existing theory-led taxonomies; (2) explicates conditions when certain uncertainty types become motivating as well as the underlying motivations explaining why these types of uncertainty propel players m2m; (3) identifies novel uncertainty types, especially *content, configuration* and *outcome uncertainty*, which were insufficiently captured in previous models. Based on prior literature and our observation within *player uncertainty,* we single out *decision uncertainty* as the most important central point of game interactions. We base this on the central role of *player uncertainty* in the loop of uncertainty placing the players' actions as the bridge between *game uncertainty* to *outcome uncertainty.* As game designers have pointed out decisions are key to game experience. *Decision uncertainty* plays the main role in propelling player's interaction decisions and thus *interaction* and *adaptation uncertainty*.

Limitations and Future Work

It is worthwhile to note that our study is intentionally limited to smaller games that can be played within approximately 10 minutes, suggesting expansion and replication for other game categories. We particularly suggest future work to look into story rich and multiplayer games which were not part of our data set. Our participants were reasonably diverse but there is always room for improvement when it comes to inclusivity.

Additionally, we focus on m2m motivation, however we acknowledge that there is value in examining the game experience as a whole and would suggest that for future work. Such paradigm and data set limitations should be examined and expanded for all studies. For example, our first investigation of manipulating macro level uncertainty our work is limited to shooters and players that are already familiar with shooters. These limitations also throw light on a larger generalizability problem in game research.

Our taxonomy suggests multiple theoretical linkages that need to be further tested. The links we suggest between types of uncertainty and motivations are fertile ground for hypothesis testing. We also suggest looking into the connections between micro and macro level experiences of uncertainty.

Lastly, there might be such uncertainty loops discussed outside of games research, for example in storytelling (the hermeneutic code (G. Long, 2007)) that we did not map our taxonomy with and suggest as future work.

Research Question 2

Can the magic forcing principle of equivoque offer design inspiration for evoking motivating decision uncertainty in players?

Research Objective 3

To survey the field of stage *magic for relevant game design inspiration, especially with relation to eliciting epistemic emotions.*

Findings and Discussion

The research provides the first literature survey of the field of stage magic with respect to its utility for games. The literature suggests that stage magic is uniquely positioned to inspire games design when it comes to evoking epistemic emotions by being a creative practice which itself greatly depends on invoking epistemic emotions. Designing stage magic tricks regularly involves eliciting motivating uncertainty. For example, magicians need their audience to be uncertain of the next step for a successful playout of the choreography of the trick.

We expose the gap that even though there has been acknowledgement of the need to take game design inspiration from other fields (Schell, 2014; W. Wright, 2001), specifically magic (Donlan, 2015; Mullich, 2016; M. Stout, 2015; W. Wright, 2001), there has been little if any substantial contribution towards transferable techniques, principles or patterns. Given the rich history of magic that has applied psychological principles to a creative format, we discover transferable techniques and methods of manipulating perceived causal sequences which can elicit epistemic emotions in multiple ways, for example, by presenting illusory choices for the audience ('forcing').

We establish that stage magic tricks pay special attention to eliciting dramatic suspense and surprise. They weave mystery, conflict and tension in a loop to elicit curiosity, uncertainty and anticipation (Ortiz, 1995). This maps onto how we found uncertainty to work through the m2m core game loop. We explain the principle of perceptual causality and how it can be used to introduce the laws of a game world and craft enjoyable trajectories of

suspense and surprise, and the design of surprising and non-frustrating puzzle sequences. We also introduce the concept of forcing, steering a perceived-free choice. We illustrate how forcing techniques like identical force, stereotypical choice patterns, visual saliency, priming and *equivoque* can be used to enhance players perceived autonomy despite limited content and guide player attention without impinging on their sense of agency.

We highlight stage magic's striking overlap with games in terms of what's presented in our work and other parallels like showmanship, consistency, visual deception which make it a compelling candidate. Our main contribution is to have showcased some valuable starting points for practitioners and comparative researchers.

Limitations and Future Work

We acknowledge that the discussed psychological mechanisms like disruption of causality or visual saliency are not unique to stage magic or games. For future work we suggest finding inspiration and working design techniques in other creative practices; for instance, other than stage magic, narrative: suspense and uncertainty play a role in theatre, film, literature etc. We use stage magic to apply basic psychological constructs and theories to games. If psychological mechanisms are at work in both these fields, this suggests future work can use games as petri dishes to further our understanding of said basic constructs and theories themselves.

We identify various stage magic principles that could be applied to games: puzzle making, user interface design, choice design etc. for eliciting various desirable player experiences. However, we did not comb through all of stage magic systematically but only reviewed it from the perspective of eliciting epistemic emotions. There must be more techniques and inspiration than those we surface. Also, at this stage we provide no scientific evidence that transferring these principles to games would work. In answering our next objectives we only test and prove the use of *equivoque* in eliciting uncertainty. We encourage researchers to empirically study and transfer unexplored principles.

We acknowledge that we only transfer uncertainty elicitation via choices from stage magic. However in our survey we bring attention to other methods (outlined by Ortiz) (Chapter 5) that we don't look into in our work: setting up mystery, causal interruptions, building tension etc. We suggest looking into these principles and systematically testing them both for evoking uncertainty but also other epistemic emotions.

Research Objective 4

To explore if equivoque can be applied to invoke decision uncertainty in games.

Findings and Discussion

This research shows that the principle of *equivoque* can invoke *decision uncertainty* and related salient experiences (perceived free choice, perceived impact) in game narratives, even in consecutively repeated choices.

We conducted three experiments to probe (1) the impact of classical *equivoque* with cards on how participants perceive their choice, (2) transferring the same technique to narrative choices in an interactive fiction game, and (3) how repeating *equivoque* choices consecutively impacts perceived choice and related player experience. The first experiment studies the functioning of *equivoque* in playing cards. Our results show that participants experienced an illusory sense of agency, i.e. perception of free choice and perception of impact over the outcome even though their actions had no impact on it. Regardless of whether the experimenter was consistent or not with participants' choices (i.e. whether chosen cards were always kept/discarded or not), participants felt that their decisions had the same amount of impact on the outcome they got. These findings support previous results showing a dissociation between our objective control and subjective sense of it (Gauchou, Rensink, & Fels, 2012; Haggard, Martin, Taylor-Clarke, Jeannerod, & Franck, 2003; Olson et al., 2015). Past research shows that this works both ways: at times we may feel that we are not in control of our own actions even when we are and the other way round (Hon, Poh, & Soon, 2013; Olson, Landry, Appourchaux, & Raz, 2016; Terhune & Hedman, 2017). For instance, at other times, we think we are in control when we are controlled by external circumstances (Aarts, Custers, & Wegner, 2005; Sato & Yasuda, 2005; Tobias-Webb et al., 2017). The *equivoque* in this study was tested on playing cards with no particularly interesting outcome or story that the participants were following. This could be one reason why participants did not pay attention to the discrepancies. In games, where the players are given a context the attachment might be higher, potentially making players more sensitive to outcome manipulation.

Hence, our next two studies tested the application of *equivoque* to game narrative design. They provide empirical evidence that the choice illusion created with *equivoque* can elicit *decision uncertainty* and related salient conditions of perceived free choice and perceived impact in games. Common narrative structures that aim to afford a sense of player choice in games, like

Time Cave or Branch and Bottleneck (Short, 2019), are cost heavy in terms of production and writing. For instance, in a Time Cave structure, each option branches into at least two more options, soon becoming a huge narrative tree. Our studies demonstrate that *equivoque* can perhaps drastically cut the costs by introducing choice illusions without compromising on the player's perception of *freedom of choice*, *impact* and *decision uncertainty*. The first of the two studies shows that *equivoque* (illusory choice/ fake choice which is actually behind the scenes no choice at all) can create higher *decision uncertainty*, higher perception of *freedom of choice* and higher perception of *impact* in comparison to players being presented with no choice at all. Just as we saw in the study done with playing cards, it makes no difference whether the paths are consistent with player choices or not.

The second of the two studies compares *equivocations* with other narrative structures. If finds that equivocations create the same amount of motivating uncertainty (by making the players feel they truly have a free choice and their choices are impactful) even when the *equivoque* technique is repeated four times. Whether people make four real, four *equivoque*, or two interleaved *equivoque* choices in different orders has no impact on the dependent variables of *decision uncertainty*, perceived *freedom of choice* and perceived *impact* on the outcome.

To conclude, we show that *equivoque* force provides people the illusion of choice and consequent *decision uncertainty,* when in reality their decision had no impact on the outcome. Participants were unmindful of the inconsistencies in decision paths, even when the procedure was repeated several consecutive times. Our work shows that *equivoque* is not limited to playing cards often used by magicians, but can be applied to narrative game choices. These findings open up the possibility of applying this principle to other game areas like levels, resources, characters, user interface etc. Our work demonstrates the ease by which players can experience responsibility and linked uncertainty over decision making and highlights a surprising blindness that people have over semantic inconsistencies in event sequences.

Limitations and Future Work

This research by showing that the use of *equivoque* can create motivating *decision uncertainty* in game narratives gives enough evidence for deriving "design inspiration for evoking motivating uncertainty in games using the stage magic principle of *equivoque*". It serves as a starting point and exemplary demonstration for looking into stage magic for inspirations beyond forcing and narrative games. However, it leaves open areas where this work can be expanded upon. To start with, *equivoque* can be tested in longer

narratives compared against other narrative structures like Branch and Bottleneck etc. (Ashwell, 2011; Short, 2019) to measure effectiveness. Beyond this we suggest *equivoque* to be tested on non-narrative choices, like a choice between paths on a platformer level or between game resources (Chapter 5, 6). Additionally, in our current research we focus on motivating uncertainty but do not check for overall enjoyment or motivation explicitly which would be an important next step. In the future, it will be also important to define the limitations of its workings. For instance, we test *equivoque* for four repetitions only, with the prerequisite that all choices presented are equally balanced options; thus limiting the generalisability beyond four repetitions or imbalanced options. Future work must also test the limitations within the nature of the semantics, for instance, how ambiguous is too ambiguous and vice versa.

As we stated in the beginning of this thesis, games are highly complex. The definition of what games are, how they affect players and the nuts-n-bolts that build them are constantly evolving. So is there business and consumption. In comparison, the research exhibited in this thesis explores limited sets or styles of games to conduct its enquiry. Moreover, while we have tried to recruit diversely, the player profile is ever widening and we are limited in the people we could recruit given the PhD's scope. This is a shared limitation with the majority of games research work which is only able to touch aspects of this intricate tapestry. Being conscious of diversity in player base and diversity in games chosen for research is key in keeping up with the dynamics of game development and ensuring that we are fostering growth for all kinds of game expressions and players. In a single research work or experimental setup we will always be limited in the game type or player base we are looking at. However, we suggest that when choosing games and players for future research we should look at game research at large and fill the missing work. In this research we take a first step by focusing on 'pick and play' games for uncertainty taxonomy and narrative games for *equivoque* studies— these are both underexplored areas in game's research. Moreover, we make it a point to find players that have different cultural, social backgrounds along with a varied gaming preference and player behaviour. We hope to set that as an example for future work in games and beyond.

Significant Contribution towards Translational Work

Games HCI, like other HCI fields, is a continuously evolving field that embraces many others (Bødker, 2015, pp. 24–31). The majority of it

implicitly aims to be practically relevant with 'implications for design'. Yet as has been often recognized in HCI research, there is a theory-practice gap (Y. Rogers, 2012). Studies have repeatedly confirmed that research insights rarely get adopted in practice (Buie et al., 2010; Colusso et al., 2017; Goodman et al., 2011; Remy et al., 2015) failing to fulfill the expectations of scientific knowledge to be useful to industry, practitioners etc. (E. M. Rogers, 2010; Stolterman, 2008). This problem trickles from the broad domain of HCI into its branches like games.

To counter this, researchers in HCI and other fields have begun developing *translational research* (Colusso et al., 2019) – work that makes a deliberate effort to translate basic research into forms relevant to practitioners. Despite that we witness little explicit engagement of this work in games. More game companies are incorporating research methods into their game development process to bridge this gap (S. Long, 2012; Mirza-Babaei et al., 2011). We see our research as a significant contribution to translational research (Colusso et al., 2019) not only for games, but also for HCI on the whole by exemplifying the translation using the combination of qualitative research, playtesting and empirical studies.

At one end of the spectrum are theoretical findings like the taxonomy of uncertainty we developed through our grounded theory investigation. The other end is focused on the design practice of effective, user-facing, interactive computing systems (Dix et al., 2003) – for instance, the approach we demonstrate in applying *equivoque* in game narratives. The gap between the two ends is the 'research-practice gap': an unsought space between research and practice (Beck & Ekbia, 2018; Goodman et al., 2011). This 'gap' problem applies to multiple fields including games and stage magic.

There have been several attempts to understand this gap and consequently overcome it (Colusso et al., 2017; Kolko, 2010; Norman, 2010; Shneiderman, 2016). Such translational research is becoming recognised as important in HCI. However, it is still (1) primarily concerned with translating from research into practice, not between creative fields, and (2) lacks explicit engagement with what it means to successfully translate in games (design) research. Zimmerman et al.'s research based design offers a model of interaction design research (Zimmerman et al., 2007) that focuses on design and exploration of theory via solving incremental design problems. Colusso et al. propose a continuum model for Translational Science in HCI that addresses the gaps in translations to facilitate the adoption and implementation of theoretical findings into design practice (Colusso et al.,

2019; Rogers, 2010). These research-practice aspects of translation are barely dealt with in games (design) research.

In relation to this discourse, our work contributes to two kinds of translation: (1) *Translation from creative practice to creative practice*: It trials a process of knowledge transfer from another creative field (stage magic) to games. It showcases how one may find meaningful inspiration in another creative field (stage magic) and systematically apply and test it in games. (2) *Translation from theory to practice*: It serves as an example in how to gather theoretical psychological research on a topic (uncertainty) and then translate it into design practice focused on eliciting the said construct.

These problems are significant when dealing with two creative fields as they both involve complex interlinkages of psychology, art, architecture and audience. A key aspect of Colusso et al.'s model of translational research is "Bubble-up" (Colusso et al., 2019; Gray et al., 2014): collecting practice knowledge from practitioners to inform research. In our case, the primary researcher is a seasoned and active game design practitioner. Throughout the PhD, she was constantly in touch with other designers and players to check if the direction of work can eventually be useful. This helped validate the zeroing of *equivoque* as a tool for improving narrative design. This also validated that game designers do not already know about the principle of *equivoque*. There are many known methods of converging a story and using illusory choices in games, however, *equivoque* is unique in terms of having an absolutely linear structure with each node working as a convergence point. Moreover, it helped narrow down on epistemic emotions as a common point of interest in developers. Knowledge gained as a game designer helped her formulate the problem around m2m gameplay motivation. From personal experience she could say that players care about interesting decisions made on a m2m level once they have bought into the game concept and already started playing the game. Having a design background she was motivated by the recurring discussion of borrowing inspiration from other fields. Game designers realise how much we are missing out on by being tunnel visioned; by only dissecting other games to inform the art. She could point out the gaps in player motivation, player experience literature from the perspective of practise for e.g. the lack of research on player curiosity. She was unsatisfied with just statistically proving that uncertainty can be willfully manipulated by the obvious change in fog of war (initial study not reported in the thesis). This didn't add to existing common knowledge in game design. Designers don't necessarily care about just proving things statistically they already hold to be true. This is why she wanted to inform designers of concepts they do not already know, e.g. *equivoque*. Being a designer it was easier to see that

equivoque could in places replace popular narrative structures like hybrids of a Time Cave. Having spent crunch time on narrative branches, the benefits of illusory choices were more obvious to spot.

The stubbornness of making the work transferable garnered its fair amount of friction. The deep dive into the field of stage magic was seen as a risky step that could harvest no results. This was at loggerheads with the time limits a PhD poses. Moreover, she did not have any proof at hand or prior research work to smoothly justify the route towards magic. This was seen as a detour rather than a convincing pathway to result. Not having a blueprint of translational work in games bloated the risks of the steps taken. There was a stage where she had to convince advisors that this was just a thing on the side, while being convinced that there could be a gold mine somewhere in the jungles of magic. Being a practitioner her aim always was to find an applicable principle that is not already known. This, she was convinced, was necessary in taking games research to game design practise. Collaborating with magic and HCI researchers had its challenges. All researchers involved had different aims ranging from contribution to psychology, contributions to magic, applications in game design or adding to game research. These fields are not fully aligned which is necessary for translation else it adds redundancy. This resulted in long time consuming conflicts in study design. It was a challenge to balance: the authenticity of magic techniques (what exactly counts as *equivoque*?), with game design issues of interaction (not having a magician to control the game pace) and lastly the variables that we all wanted measured to benefit each field. The magic researchers she collaborated with weren't well versed in concepts like uncertainty in games and found that investigation in games hard to understand or engage with. On the other hand HCI researchers were not too sure about the workings of *equivoque* to easily grasp the hurdles of implementing it into game narrative branching. We overcome this by iteration on experiment design. At one stage the best possible way to go forward was to show results by conducting playtests rather than debating priorities. It was an important lesson to learn that nobody had the complete picture and the researcher herself was in the best position to look at both fields keeping in mind the end goal of design inspiration. Winn & Heeter make similar observations about team composition and process in translational research: they say that one needs a team of specialists from each involved discipline and conflict resolution through playtesting in early phases of game development to make a serious game (Winn & Heeter, 2006).

Analysing this personal trajectory we suggest having one such person (practitioner) on the team if possible or creating online groups with

designers/developers to inform and validate the research work, even if informally. This is crucial in keeping the end goal of practical application in mind and designing studies and surveys towards this goal. We suggest risk analysis of such uncharted paths to keep expectations in check. For example, we were very clear that we won't be able to establish any of the stage magic principles in a very generalisable manner given the diverse nature of games. It was important for us to publish the work as we did it to get outside support and feedback. We suggest having this sort of an incremental approach where each bit can be seen as a substantial contribution. Lastly, it is important for the team to remember that research work that wants to pave a new path (in this case transfer applicable knowledge from stage magic to games and theory to practise) will have unforeseen turns. Trusting the groundwork done and insights that are not yet backed in literature but come with practical experience is valuable.

During the research work that involved magic, the researcher actively became part of Magic Lab i.e. a group of practising magicians and scientists working on Science of Magic. The researcher collaborated on studies and also attended a conference that discussed "The Science of Magic". This involvement with practitioners from both fields allowed validation of adaptations by both game experts and stage magic experts. This showcases the 'Bubble Up' confluence informing the entire continuum of the research. This helped looking at the problem from a completely new perspective. For example, for the first study we did not think much about games but simply focused on *equivoque* itself to gain expertise with respect to the principle. Attending the magic conference opened up the mind to understanding the application of stage magic in other fields like well-being (Bagienski & Kuhn, 2019). Not only did such a set up allow for easier access to literature but also opened gates to experts one could reach out to. Doing a study with the Magic Lab was tricky because of differing goals and methodology. This collaboration is beneficial if the two field experts can find common goals. In this both of us were interested in forcing and forcing was being scientifically explored for the first time, be it games or magic. We do not recommend getting too deep into such a collaboration if it is taking valuable time to find common ground or the process is wavering the researcher away from their own research objectives.

Conducting a grounded theory to get theoretical insight into uncertainty before making an attempt to apply it to design helped the process of translation. The theory development helped us gain understanding of the workings of uncertainty and its impact on players. It enabled us to zero down on *decision uncertainty* around which we could focus our goals regarding

practical game design. In terms of finding valuable insight in the field of stage magic, our work showcases that by doing a macro evaluation from a chosen lens, in this case, from the lens of epistemic emotions allows us to carve through a massive amount of data, in this case, from the field of stage magic. We applied a more refined focus only when we reached a point where we could see a possible transferable principle. We identified the illusion of choice and related epistemic emotions as a common link between our quest and existing principles in stage magic and only then tried application in games. In this process we tested the phenomenon independently first and only once we felt confident in the workings of *equivoque* we tried embedding it into games. We did a series of playtests of our games to make sure that *equivoque* doesn't feel shoehorned into game narratives but fits naturally in players' experience of the game. Often game research empirical studies miss this step and directly test them scientifically. This makes these games less ecologically reliable. On the other hand, most practitioners do not test their hypotheses empirically with respect to particular player experiences and the playtest data could be biased by sample size or developer intervention. We are not suggesting practitioners to conduct such studies but we do see value and providing these example answers for them. The interleaving of quantitative studies with regular playtests allowed us to iterate on the design and make it robust for both parties. Lastly, the dependent variables and method of data collection were kept the same as we used with the playing cards (in collaboration with Magic Lab), with the addition of uncertainty questions to keep the translation seamless. This way we know our results are not influenced by the variation in style of data collection.

What worked really well for us was analysing the field with respect to eliciting epistemic emotions before jumping into details of *equivoque*. The broad survey on stage magic principles allowed us to compare and contrast different techniques in terms of transferability within the PhD scope. We could look at the cost of transfer, for example, transferring visual saliency with billboards in a racing game would mean developing high quality racing games to conduct the study. Although an interesting hypothesis, this would not have been possible in the time we had. The overarching view also allowed us to differentiate more conceptual translations with definable translations. For example, understanding causality and its violation needs designers to be conscious of causality when designing tutorials rather than simply applying a principle. *Equivoque* on the other hand is a more defined principle that follows some semantic rules that can be tested with respect to specific player experiences. Both require skill but prescribable options like *equivoque* are more testable because of the concrete definition they have.

Alternatively, the method of boiling the entire ocean of stage magic to find principles: to compare and contrast each and every principle to pick one is not only time consuming but can lead to being lost in the intricacies of the new field. We looked at stage magic from the lens of epistemic emotions which is still a sizable chunk. As stated earlier, not having a roadmap to unknown paths can lead to mistrust in the team and demotivation. If you are not confident that this approach would yield results, we suggest picking the most obvious principles to test or collect observations around rather than excessive theorising.

In our knowledge, our research is a first example of translational work from a creative field (stage magic) to games using iterative game design mixed with quantitative and qualitative methods. This should provide insights for future HCI and game researchers, especially when they see the need of transferring work from other creative fields. At the very beginning of the thesis we stated that individual game designers have been poaching from all other creative domains for a long time. However, till now, there is limited research applying and testing this 'poaching' with respect to specific player experience constructs. Research like ours can help understand and support these kinds of translations between creative practice fields. With our work we make it possible for designers to apply *equivoque* into their narrative branches and expect it to behave like a real choice.

Translating to Industry

The research work presented in this thesis garnered attention from academic and industrial experts of both fields (Develop Conference, 2020; GameHappens, 2019; Gamekult, 2019; J. Goldberg, 2020; IndieCade Europe, 2019a, 2019b; Kuhn, 2019, pp. 203–205; Kumari, Deterding, & Freeman, 2019; Kumari, Deterding, & Kuhn, 2019; Kumari et al., 2018, 2017; Pritchard, 2019). We suspect that transference of applications between creative fields using popular examples allows practitioners to consume information more readily. This was evident in the post presentation discussions and email follow ups. Furthermore, having a working *equivoque* example helped convince practitioners that such transference from stage magic could work. We were able to collaborate with game companies (Shirodkar, 2020) to brainstorm usage in their products. The potential applications discussed in Chapter 5 and Chapter 6 show that there is much that can be implemented. Some of which have already been, even though accidentally (see section Identical Choice in Chapter 5). The issue with accidental or one-off application of stage magic principles makes it hard to replicate, generalise or even find. As explained in Chapter 5 and Chapter 6, we propose that

equivoque can be used beyond game narratives into level design, user interface design and resource allocation design to create motivating uncertainty in players. Practitioners have discussed applying stage magic to games (Scheurle, 2018; W. Wright, 2001) and with our work we exemplify a solid step in making an evaluated effort towards such application.

Translating to Stage Magic

Forcing principles of *equivoque* used in stage magic had not been tested scientifically in the field of magic research. This research collaborates with magic researchers and provides empirical evidence regarding the strength of *equivoque* with respect to creating a perception of free choice and impact in its audience. This line of work informs both fields and expands their scope of future investigation and application. The application of magic principles in other fields like well being, games etc. is an important goal set out by magic and psychology researchers (Kuhn et al., 2008). Research like the one contributes to that goal. The science of magic is a fairly new field. Our work provides further validation to magic as a field amongst a wider influence.

Concluding Remarks

This thesis hopes to evidence the treasure troves of information we can borrow and exchange between creative fields. It is an exemplar for game designers and researchers in how to take design inspiration from other fields and test them with respect to specific player experiences. This is something games design has repeatedly acknowledged but so far, not provided rigorous means of doing so. A large part of player motivation and player experience literature looks at games at a macro level, missing out on the nitty gritty details, whereas most game design practitioners can tell that beyond conceptualisation, the crux of design lies in the interaction of systems at a m2m game loop level which elicits immediate experience that feeds into the overall experience of the game. This is the second intention of this thesis: to demonstrate the need to look at m2m gameplay and also showcase the rich data available at that level to be explored and unpacked. Stage magic has been an important vehicle in making these points and showing how much we can learn from adjacent fields. That said, we believe, this is only a step and we must continue our 'plundering' — poetry, music, movies, storytelling, architecture await our scientific and designerly incisions.

Appendices

A. Experiment Documentation: The Role of Uncertainty in 'Moment to Moment' Player Motivation (Grounded Theory)

Interview Information Sheet

We are inviting you to take part in a research study. This sheet will provide you with information about the study. You may ask the researcher any questions you may have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you for your consent separately.

You will be debriefed after the interview with more details about the project.

Study Overview
The study is being conducted to identify player's motivations to play games which are easy to learn and are easily accessible. It is to gather in depth information about why people play these types of games and what are their motivations for continued engagement.

In this study, you will be asked a set of questions in an interview format. These questions will be regarding your player behaviour and past player experiences, the interview session should run for no longer than an hour. The researcher will go in depth and ask questions based on your replies. The interview will take place online or in person at Goldsmiths University. We will also record any text exchanged over online interviews if your interview was performed online.

Withdrawing
You are free to withdraw from this study at any point, without penalty and without giving a reason. If you decide to withdraw your data will be removed and destroyed. If at any point you do not want to answer a question, then please tell the researcher.

Clarifications

If you want to clarify anything about the study please feel free to ask them during the course of the study. If you have any questions about your rights in this research, you may contact Ms. Anna Bramwell-Dicks, Department of Theatre, Film and Television Ethics Committee at the University of York, Baird Lane, Heslington East Campus, York, YO10 5GB, UK, +44 (0) 1904 32 5244, tftv-ethics@york.ac.uk. You may call anonymously if you wish.

Data

We are audio recording your interview which will later be transcribed digitally and used for data analysis. We will also record any text exchanged over online interviews if your interview was performed online.

Your information will be completely anonymised and will be associated with a unique ID which the researcher will share with you at the beginning of the study.

All data and documentation from the research will be confidential and will be stored securely. Moreover, all references to participants in any reports or publicly available material will be anonymised. Data will be stored on a secure data storage device and a copy will remain with The University of York for upto 10 years. Only the researchers (Shringi Kumari, Sebastian Deterding and Jonathan Freeman) will have access to this data.

Contact

Primary Researcher - Shringi Kumari
Email: sk1382@york.ac.uk
Phone: +447397545256
Address:
YCCSA, Ron Cooke Hub
University of York
Heslington
York
YO10 5GE

Supervisor - Sebastian Deterding
Email: sebastian.deterding@york.ac.uk

Benefits

- You do not directly benefit in anyway, however, the study may help game designers in making games that you may like to play

- There are no incentives to participate in the study. Your participation is voluntary.

Funding

This research is paid for by the EPSRC grant for the IGGI doctoral training school, grant reference EP/L015846/1. For more information, see https://iggi.org.uk

Information Sheet for Play Session and Interview

We are inviting you to take part in a research study. This sheet will provide you with information about the study.
You may ask the researcher any questions you may have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you for your consent separately.

You will be debriefed after the session with more details about the project.

Study Overview
The study is being conducted to identify player's motivations to play games which are easy to learn and are easily accessible. It is to gather in depth information about why people play these types of games and what are their motivations for continued engagement.

In the play session you will be asked to play a 10 minute session of a game you are familiar with on mobile. Your play data will be collected by capturing the screen. Your reactions will also be audio recorded along with this.

Within 12 weeks we will be inviting you for an interview where we will ask questions with reference to your experience during the play session. There will be other questions regarding your player behaviour and past player experiences, the interview session should run for no longer than an hour. The researcher will go in depth and ask questions based on your replies. The interview will take place online or in person at Goldsmiths University.

Withdrawing
You are free to withdraw from this study at any point, without penalty and without giving a reason. If you decide to withdraw your data will be removed and destroyed.

Clarifications
If you want to clarify anything about the study please feel free to ask them during the course of the study. If you have any questions about your rights in this research, you may contact Ms. Anna Bramwell-Dicks, Department of Theatre, Film and Television Ethics Committee at the University of York, Baird Lane, Heslington East Campus, York, YO10 5GB, UK, +44 (0) 1904 32 5244, tftv-ethics@york.ac.uk. You may call anonymously if you wish.

Data

We are audio recording your reactions while you play the game which will later be transcribed digitally and used for data analysis. We will also capture the screen recording of the gameplay on mobile.

We will audio record your interview which will later be transcribed digitally and used for data analysis. We will also record any text exchanged over online interviews if your interview was performed online.

Your information will be completely anonymised and will be associated with a unique ID which the researcher will share with you at the beginning of the study.

All data and documentation from the research will be confidential and will be stored securely. Moreover, all references to participants in any reports or publicly available material will be anonymised. Data will be stored on a secure data storage device and a copy will remain with The University of York for upto 10 years. Only the researchers will have access to this data.

Contact

Primary Researcher - Shringi Kumari
Email: sk1382@york.ac.uk
Phone: +447397545256
Address:
YCCSA, Ron Cooke Hub
University of York
Heslington
York
YO10 5GE

Supervisor - Sebastian Deterding
Email: sebastian.deterding@york.ac.uk

Benefits

- You do not directly benefit in anyway, however, the study may help game designers in making games that you may like to play
- There are no incentives to participate in the study. Your participation is voluntary.

Funding
This research is paid for by the EPSRC grant for the IGGI doctoral training school, grant reference EP/L015846/1. For more information, see https://iggi.org.uk

Information Sheet for Diary Entry and Interview

We are inviting you to take part in a research study. This sheet will provide you with information about the study.

You may ask the researcher any questions you may have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you for your consent separately.

You will be debriefed after the session with more details about the project.

Study Overview

The study is being conducted to identify player's motivations to play games which are easy to learn and are easily accessible. It is to gather in depth information about why people play these types of games and what are their motivations for continued engagement.

You will be asked to make entries of your player behaviour spanning over 1 week. You will be given a format to follow to complete these entries as a short online Google form. You are asked to complete daily entries (at the end of each day) for a week.

Within 12 weeks we will be inviting you for an interview where we will ask questions with reference to your diary entries along with questions regarding your player behaviour and past player experiences. The interview session should run for no longer than an hour. The researcher will go in depth and ask questions based on your replies. The interview will take place online or in person at Goldsmiths University. We will also record any text messages exchanged over online interviews if your interview was performed online.

Withdrawing

You are free to withdraw from this study at any point, without penalty and without giving a reason. If you decide to withdraw your data will be removed and destroyed.

Clarifications

If you want to clarify anything about the study please feel free to ask them during the course of the study. If you have any questions about your rights in this research, you may contact Ms. Anna Bramwell-Dicks, Department of Theatre, Film and Television Ethics Committee at the University of York, Baird

Lane, Heslington East Campus, York, YO10 5GB, UK, +44 (0) 1904 32 5244, tftv-ethics@york.ac.uk. You may call anonymously if you wish.

Data

Your diary entries will be recorded in Google forms later stored as text in spreadsheets. Your interview will be audio recorded which will later be transcribed digitally and used for data analysis. We will also record any text exchanged over online interviews if your interview was performed online.

Your information will be completely anonymised and will be associated with a unique ID which the researcher will share with you at the beginning of the study.

All data and documentation from the research will be confidential and will be stored securely. Moreover, all references to participants in any reports or publicly available material will be anonymised. Data will be stored on a secure data storage device and a copy will remain with The University of York for upto 10 years. Only the researchers will have access to this data.

Contact

Primary Researcher - Shringi Kumari
Email: sk1382@york.ac.uk
Phone: +447397545256
Address:
YCCSA, Ron Cooke Hub
University of York
Heslington
York
YO10 5GE

Supervisor - Sebastian Deterding
Email: sebastian.deterding@york.ac.uk

Benefits

- You do not directly benefit in anyway, however, the study may help game designers in making games that you may like to play
- There are no incentives to participate in the study. Your participation is voluntary.

Funding
This research is paid for by the EPSRC grant for the IGGI doctoral training school, grant reference EP/L015846/1. For more information, see https://iggi.org.uk

Informed Consent for Interviews

I confirm that,
**Required*

1. I have read and understood the information provided on the information sheet. *
☐Yes
☐No

2. I have been given the opportunity to ask questions about the study and my participation in the study. *
☐Yes
☐No

3. I agree to take part in the study where I will be interviewed and audio recorded. If the interview is held online, text messages shared during the interview will also be recorded. *
☐Yes
☐No

4. I understand that my taking part is voluntary; I can withdraw from the study at any time without penalty. I do not have to give any reasons for why I no longer want to take part. *
☐Yes
☐No

5. I understand my personal details such as name, skype id, email id, will not be revealed to anyone except the primary researcher. *
☐Yes
☐No

6. I understand and agree to use and storage of data and that my data will be stored securely and kept confidential.
☐Yes
☐No

7. I understand that the data being collected can be used for publications after being anonymised. *
☐Yes
☐No

8. ID *

_____

9. Please enter your email id if you are interested in the results of this study

_____

Name of Researcher: Shringi Kumari
sk1382@york.ac.uk

Informed Consent for Play Session and Interview

I confirm that,
**Required*

1. I have read and understood the information provided on the information sheet. *
☐Yes
☐No

2. I have been given the opportunity to ask questions about the study and my participation in the study. *
☐Yes
☐No

3. I agree to take part in the project where my gameplay data will be screen captured and my reactions will be audio recorded. *
☐Yes
☐No

4. I agree to take part in the study where I will later be interviewed and audio recorded. If the interview is held online, text messages shared during the interview will also be recorded. *
☐Yes
☐No

5. I understand that my taking part is voluntary; I can withdraw from the study at any time without penalty. I do not have to give any reasons for why I no longer want to take part. *
☐Yes
☐No

6. I understand my personal details such as name, skype id, email id, will not be revealed to anyone except the primary researcher. *
☐Yes
☐No

7. I understand and agree to use and storage of data and that my data will be stored securely and kept confidential.
☐Yes
☐No

8. I understand that the data being collected can be used for publications after being anonymised. *
☐Yes
☐No

9. ID *
_____

10. Please enter your email id if you are interested in the results of this study
_____

Name of Researcher: Shringi Kumari
sk1382@york.ac.uk

Informed Consent for Diary Entries and Interviews

I confirm that,
**Required*

1. I have read and understood the information provided on the information sheet. *
☐Yes
☐No

2. I have been given the opportunity to ask questions about the study and my participation in
the study. *
☐Yes
☐No

3. I agree to take part in the project where my diary entries will be recorded as Google Forms and later stored in spreadsheets *
☐Yes
☐No

4. I agree to take part in the study where I will later be interviewed and audio recorded. If the interview is held online, text messages shared during the interview will also be recorded. *
☐Yes
☐No

5. I understand that my taking part is voluntary; I can withdraw from the study at any time without penalty. I do not have to give any reasons for why I no longer want to take part. *
☐Yes
☐No

6. I understand my personal details such as name, skype id, email id, will not be revealed to anyone except the primary researcher. *
☐Yes
☐No

7. I understand and agree to use and storage of data and that my data will be stored securely
and kept confidential.

☐Yes
☐No

8. I understand that the data being collected can be used for publications after being
anonymised. *
☐Yes
☐No

9. ID *
_____

10. Please enter your email id if you are interested in the results of this study
_____

Name of Researcher: Shringi Kumari
sk1382@york.ac.uk

Screening Questionnaire

Information

This study is being conducted to identify player's motivations and to gather in-depth information about why people play games and what are their motivations for continued engagement.

You may ask the researcher any questions you may have. We will be collecting your game and platform preferences along with demographic data (age, gender and occupation). You can choose to not answer any of the questions or abort the questionnaire at any point without any penalty or need to give a reason.

You will be given further information in case you are chosen for the complete study.

Your name and email id can be seen only by Shringi Kumari and will be destroyed right after the screening process. Your information will be completely anonymised and replaced with a unique ID which the researcher will share with you at the beginning of the study when inviting you for the complete study. Rest of the screening data collected as a spreadsheet can be viewed only by the 3 researchers conducting this study.

All data and documentation from the research will be confidential and will be stored securely. Moreover, all references to participants in any reports or publicly available material will be anonymised. Data will be stored on a secure data storage device and an anonymised copy will remain with The University of York for up to 10 years.

Contact

Primary Researcher Shringi Kumari
Email: sk1382@york.ac.uk
Phone: +447397545256
Address: YCCSA, Ron Cooke Hub
University of York
Heslington
York
YO10 5GE
Supervisor Sebastian Deterding

Email: sebastian.deterding@york.ac.uk

Informed Consent

I confirm that,

**Required*

1. I have read and understood the information provided in the information section. *

☐Yes

☐No

2. I understand that I can ask questions about the screening or the study and my participation prior to filling the questionnaire. *

☐Yes

☐No

3. I agree to fill in the questionnaire which will be recorded to screen for the study and to the use of data that will be stored securely and kept confidential.*

☐Yes

☐No

4. I understand my personal details such as name, email id, will not be revealed to anyone except the primary researcher. *

☐Yes

☐No

5. I understand that the data being collected can be used for publications after being anonymised. *

☐Yes

☐No

Screening Questionnaire

6. Name *

_____

7. Email/ your preferred way of being contacted

_____

8. Age

☐18 - 24

☐25 - 34

☐35 - 44
☐45 - 54
☐55 - 64
☐65 or older
☐Don't want to answer

9. Gender
☐Male
☐Female
☐Other
☐Don't want to answer

10. Occupation
_____

11. Games you have enjoyed the most (game names and platforms e.g. Tetris on mobile, ...)
_____
_____
_____
_____
_____
_____
_____
_____
_____

12. Games you have been playing lately (game names and platforms)
_____
_____
_____
_____
_____
_____
_____
_____
_____

13. What are your preferred platforms for playing games
☐Mobile (Tablet/ phone)
☐PC
☐Handheld Console

☐Console (PlayStation/ Xbox/ Wii)
☐No preference
☐None of the above

14. If you are playing on your mobile, please list the games you are playing or have recently played

_____
_____
_____
_____
_____
_____
_____
_____
_____

15. How often do you play games
☐At least once a day
☐At least once a week
☐At least once a month
☐At least once a year
☐Less often
☐Can't really say as it varies quite a bit

Name of Researcher: Shringi Kumari

Notes for Interview Questions

Which game have you been playing lately? (If the answer is not a small game – Bring up the small game from screening form) When did you last play this game?

Contexts of Choosing and Motivation
When did you pick it the last time?
Where were you when you picked this game the last time?

Other social media?
How do you discover new games?

What happened before you picked the game?
What were you thinking when you picked the game?
Why did you pick a game?
What did you expect from the game?
Why did you pick this particular game?
Why do you think you play a game like <chosen game>?

Can you describe the situation when you last picked the game in more detail?

Would you say this was a typical situation for you picking this game? (Why? Why not?)

What are (other) typical situations when you pick up this game? Last time?

Are there any other simple games you regularly play?

Games that have stopped ?

Have you picked this game up in different kinds of situations then the ones you described? Can you describe them?

Motivation
Why do you think you play games like [list of different games mentioned]? Do you prefer one game over the other? Why?

What *else do you do in your free time* that gives you similar experience to playing this game?

Motives relating to Game Features

Can you describe your last play session and your *experience* with the game?

When you played last time, what did you enjoy in the game in particular?

Was there *something specific in the game that gave rise to that experience*?
Can you describe it?

Are there other activities or games that give you the same experience?

Are there other typical experiences with this game that you enjoy? Which ones?
[For each experience listed:] Can you describe it?
Was there something specific in this game that gave rise to that experience?
Can you describe it?
Are there other activities or games that give you the same experience?

How long did you play the game for? Why did you keep going? Anything specific in the game that made you continue?
Are there other activities or games that give you the same experience?

Are there other typical experiences with this game that made you continue, or want to continue? Which ones?
[For each experience listed:] Can you describe it? Was there something specific in the game that gave rise to that experience? Can you describe it?
Are there other activities or games that give you the same experience?

Which game have you played the most? (if not a casual game steer towards one)? Why?

Now if you think back of the other casual games you play regularly: Do they give you different enjoyable experiences? Which ones? (Enquire in depth as above.)

Do they give you different experiences that make you continue, or want to continue? Which ones? (Enquire in depth as above.)

onboarding??

Disengaging

Going back to the first game we started with: When you last played it, when did you stop playing the game in that situation? Why?

How did you feel after the game session?

How long did you play the game for? Why did you stop? Anything specific in the game that made you stop?

Is that a typical reason for stopping? (Why? Why not?)
Are there other typical reasons why you stop playing this game? (Describe.)

Now if you think of the other casual games you've played: Are there other typical reasons why you stop playing them. (Describe.)

Have you ever stopped playing a casual game completely, not picking it up again?
[If yes:] Which one? Can you describe the last time you remember playing it? What went through your head that you didn't pick it up again? What happened that you didn't pick it up again?

Are there other games you stopped playing completely?
[For each:] What happened there?

REFER TO DIARY ENTRY DURING THE INTERVIEW

Observation Points During Playthrough

Player actions/ expressions

- When are they frustrated
- When do they show excitement
- When are they thinking
- How do they react to rewards and feedback
- How do they react when getting closer to the goal
- Where do they look surprised/ curious etc (if at all)
- *What does the player express at the end*

Game

- *Where are they stuck*
- What parts they breeze through
- *What is hard about the problem, how do they tackle it*
- How does the game introduce the problem-------!!!!!!!!!!!
- How does the game create surprise, does it work?-----!!!!!!
- GOALS AND STUFF
- Overall : What is the problem curve (and the player's journey with it)

- Ask Questions around the observations similar to initial questions
- How did they find the session (Get deeper with adding observations to enrich the question)
- *What do they think was interesting about the session? (Get deeper with adding observations to enrich the question)*
- Were you expecting the events in the game? What did you expect from the game?
- Were they curious? Was there *something specific in the game that gave rise to that experience*? Can you describe it?
- What kept you engaged on a moment to moment level?
- What kept you going from moment to moment?
- Was it pick and play ? why?
- What's exciting?
- What are they looking forward to?
- If they were stuck, what did they think of that bit? What did they find hard?
- Was the problem clear? What made the problem worth solving?
- What other kinds of problems do they like to solve
- Do they see similarities
- Did they make any meaningful decisions? How else could they have solved the problem?

- If they lost : would they like to try again?
- If they won : would they like to master?

Diary Entry Fields

Your ID, day no., session no (eg. ID #2, Day 01, session 01)

_____

Game Name, Platform

_____

Date and Time

_____

Where exactly were you when you played the game? (describe in as much detail as you can about your location e.g home, on the couch, lying down)

_____
_____
_____

Why did you pick a game in this situation? (describe in as much detail as you can)

_____
_____
_____

Why did you pick this particular game? (describe in as much detail as you can)

_____
_____
_____

What did you expect from this game? (describe in as much detail as you can)

_____
_____
_____

Length of session

_____

What in the game kept you going for this long? (describe in as much detail as you can)

_____
_____

B. Experiment Documentation: Equivoque with Playing Cards

Informed Consent

I freely and voluntarily consent to be a participant in the research project entitled "Magic tricks and decision making" to be conducted at Goldsmiths, with Gustav Kuhn as supervisor.

I have been told that my responses will be kept strictly confidential. I also understand that if at any time during the session I feel unable or unwilling to continue, I am free to leave without negative consequences. I have any general questions about this project, or ethical issues relating to the project, I should feel free to contact Gustav Kuhn at G.kuhn@gold.ac.uk.

I have read and understand the above and consent to participate in this study. My signature is not a waiver of any legal rights. Furthermore, I understand that I will be able to keep a copy of the informed consent form for my records.

_____ _____ _____

Participant's Signature Name Date

Questions

On a scale from 0 (not free at all) to 100 (extremely free), how free did you feel to choose the card(s) you put your hands on?

_____

On a scale from 0 (no impact at all) to 100 (extreme impact), how much impact did you feel your choices had on the final card?

_____

Gender : _____
Age : _____

Thank you for your participation ! 😊

C. Experiment Documentation: Equivoque in Narrative Games

Information Sheet

Please play the game on laptop/desktop/tablet. The game is not optimised for mobile.

Thank you for your participation.

This sheet will provide you with information about the study. You may ask the researcher any questions you may have using the contact details given below. If you decide to participate, your consent will be asked separately.

You will be debriefed after the study with more details about the project if you like.

Study Overview
The study is being conducted to gather information about how players deal with choice in a game environment.

In this study, you will play a game segment on your browser. You will then be asked to fill a questionnaire regarding your player experience. The game session will take you 3 minutes (approximately) and the questionnaire should take 2 minutes (approximately) of your time. It is an online study that you will participate in remotely. We will record your play data and your answers.

If you have agreed to be a playtester, the researcher will observe your play, read your play data, based on which, you will be asked questions regarding your player experience to help develop the game and future studies. Your answers will be audio recorded if asked in person or recorded as text exchanged on online platforms.

Withdrawing
You are free to withdraw from this study at any point, without penalty and without giving a reason. If you decide to withdraw your data will be removed and destroyed.

Clarifications
If you want to clarify anything about the study please feel free to ask them during the course of the study.

Data
Your personal information will only be visible to the primary investigator which will later be completely anonymised and will be associated with a unique ID.
All data and documentation from the research will be confidential and will be stored securely. Moreover, all references to participants in any reports or publicly available material will be anonymised. Data will be stored on a secure data storage device and a copy will remain with The University of York for upto 10 years. Only the researchers (Shringi Kumari, Sebastian Deterding, Gustav Kuhn and Jonathan Freeman) will have access to this data.
After the conclusion of data collection, we may upload fully anonymised data publicly to the Open Science Foundation repository (osf.io) to enable future researchers to work with it.

Contact
Primary Researcher - Shringi Kumari
Email: sk1382@york.ac.uk
Phone: +447397545256
Address:
YCCSA, Ron Cooke Hub
University of York
Heslington
York
YO10 5GE

Supervisor - Sebastian Deterding
Email: sebastian.deterding@york.ac.uk

Benefits
You do not directly benefit in any way, however, the study may help game designers in making games that you may like to play.
There are no incentives to participate in the study. Your participation is voluntary.

Funding
This research is paid for by the EPSRC grant for the IGGI doctoral training school, grant reference EP/L015846/1. For more information, see https://iggi.org.uk

Demographic Data Form

Prolific id (if applicable else enter any alphabet)*

_____

Name*

_____

Which device are you playing on:*

Please play the game on Laptop/Desktop/Tablet. The game is not optimised for mobile.

☐ Laptop or Desktop
☐ Tablet
☐ Mobile
☐ Other- please specify

Age:*
☐ 18 - 24
☐ 25 - 34
☐35 - 44
☐ 45 or older
☐Prefer not to say

Gender:*
☐ Female
☐ Male
☐ Prefer not to say
☐ Other- if you wish to specify _____

Please enter you email if you are interested in the results of this study

_____

Name of Researcher: Shringi Kumari
sk1382@york.ac.uk

Informed Consent Form

I confirm that,
**Required*

1. I have read and understood the information provided on the Game experiment information sheet.*
☐Yes

2. I have been informed that I can ask questions about the study and my participation in the study.*
☐Yes

3. I voluntarily agree to participate in the study.*
☐Yes

4. I can withdraw at any time without giving a reason and there is no penalty for withdrawing.*
☐Yes

5. The use of the data for research and publications has been explained to me in the information sheet.*
☐Yes

Name of Researcher: Shringi Kumari
sk1382@york.ac.uk

Games

Games to Study: Using *Equivoque* to Afford Motivating Uncertainty in Games

Game with no choice
https://www-users.york.ac.uk/~sk1382/osaka/

Game with a single fake choice
https://www-users.york.ac.uk/~sk1382/osaka_two/

Games to Study 'Does *Equivoque* work if repeated?'

Game: Condition All Fake
https://www-users.york.ac.uk/~sk1382/Osaka_FF/

Game: Condition All Real
https://www-users.york.ac.uk/~sk1382/Osaka_RR/

Game: Condition Fake-Real-Fake-Real
https://www-users.york.ac.uk/~sk1382/Osaka_FR/

Game: Condition Real-Fake-Real-Fake
https://www-users.york.ac.uk/~sk1382/Osaka_RF/

Overall Decision Uncertainty (Post Hoc Analysis)

Post Hoc Comparisons – Game Conditions					
		Mean Difference	SE	t	p_{tukey}
All Fake	All Real	2.301	3.436	0.670	0.908
	Fake-Real-Fake-Real	-6.353	3.419	-1.858	0.250
	Real-Fake-Real-Fake	-6.267	3.472	-1.805	0.274
All Real	Fake-Real-Fake-Real	-8.654	3.436	-2.519	0.060
	Real-Fake-Real-Fake	-8.568	3.489	-2.456	0.070
Fake-Real-Fake-Real	Real-Fake-Real-Fake	0.086	3.472	0.025	1.000

Table 12. Post hoc analysis of overall *Decision Uncertainty* in the study of *equivoque* repetitions

Decision Uncertainty: Fourth Decision (Post Hoc Analysis)

Post Hoc Comparisons – Game Conditions					
		Mean Difference	SE	t	p_{tukey}
All Fake	All Real	2.371	4.669	0.508	0.957
	Fake-Real-Fake-Real	-4.765	4.646	-1.026	0.735
	Real-Fake-Real-Fake	-8.216	4.718	-1.741	0.305
All Real	Fake-Real-Fake-Real	-7.136	4.669	-1.528	0.423
	Real-Fake-Real-Fake	-10.587	4.741	-2.233	0.118
Fake-Real-Fake-Real	Real-Fake-Real-Fake	-3.451	4.718	-0.731	0.884

Table 13. Post hoc analysis of *Decision Uncertainty* players felt for the fourth choice in the study of *equivoque* repetitions

References

Aarts, H., Verplanken, B., & Knippenberg, A. (1998). Predicting Behavior From Actions in the Past: Repeated Decision Making or a Matter of Habit? *Journal of Applied Social Psychology*, *28*(15), 1355–1374.

Abuhamdeh, S., & Csikszentmihalyi, M. (2012). The importance of challenge for the enjoyment of intrinsically motivated, goal-directed activities. *Personality & Social Psychology Bulletin*, *38*(3), 317–330.

Abuhamdeh, S., Csikszentmihalyi, M., & Jalal, B. (2015). Enjoying the possibility of defeat: Outcome uncertainty, suspense, and intrinsic motivation. *Motivation and Emotion*, *39*(1), 1–10.

Adams, E. (2014). *Fundamentals of game design*. Pearson Education.

Amanita Design. (2012). *Botanicula*. Amanita Design.

Annemann, T. (2011). *For Magicians Only: 202 Methods of Forcing*. Wildside Press, LLC.

Anthropy, A. (2013). *Queers in Love at the End of the World*.

Arnold, F. (1910). *Attention and interest: A study in psychology and education*. Macmillan.

Arnold, M. B. (1970). Perennial problems in the field of emotion. *Feelings and Emotions: The Loyola Symposium*, 169–186.

Ashwell, S. K. (2011, August 5). *CYOA structure: The Cave of Time*. These Heterogenous Tasks. https://heterogenoustasks.wordpress.com/2011/08/05/cyoa-structures-the-cave-of-time/

Ashwell, S. K. (2015, January 27). *Standard Patterns in Choice-Based Games*. These Heterogenous Tasks. https://heterogenoustasks.wordpress.com/2015/01/26/standard-patterns-in-choice-based-games/

Aunger, R., & Curtis, V. (2013). The Anatomy of Motivation: An Evolutionary-Ecological Approach. *Biological Theory*, *8*(1), 49–63.

Bae, B. C., & Young, R. M. (2008). A Use of Flashback and Foreshadowing for Surprise Arousal in Narrative Using a Plan-Based Approach. *Interactive Storytelling*, 156–167.

Bagienski, S., & Kuhn, G. (2019). The crossroads of magic and wellbeing: A review of wellbeing-focused magic programs, empirical studies, and conceivable theories. *International Journal of Wellbeing*, *9*(2). http://www.internationaljournalofwellbeing.org/ijow/index.php/ijow/article/view/740

Baker, T. (2019, April 18). *Design/Play/Disrupt at the V&A Dundee celebrates the cultural importance of videogames*. Creative Boom. https://www.creativeboom.com/inspiration/design-play-disrupt-at-the-va-dundee-celebrates-the-cultural-importance-of-videogames/

Bal, M., & van Boheemen, C. (2009). *Narratology: Introduction to the Theory of Narrative*. University of Toronto Press.

Ballou, E. (2019, December 23). *The Walking Sim Is a Genuinely New Genre, And No One Fully Understands It*. Vice. https://www.vice.com/en_us/article/wxeqzw/the-walking-sim-is-a-genuinely-new-genre-and-no-one-fully-understands-it

Banachek. (1998). *Psychological Subtleties*. Magic Inspirations Houston, Texas.

Banachek. (2009). *Psychological Subtleties*. Magic Inspiration.

Banachek, Wells, S. R., & Christopher Gillett, S. (2002). *Psychophysiological Thought Reading, Or, Muscle Reading and the Ideomotor Response Revealed*. Magic Inspirations.
Baranes, A., Oudeyer, P. Y., & Gottlieb, J. (2015). Eye movements reveal epistemic curiosity in human observers. *Vision Research*, *117*, 81–90.
Bar-Hillel, M. (2015). Position Effects in Choice From Simultaneous Displays: A Conundrum Solved. *Perspect. Psychol. Sci.*, *10*(4), 419–433.
Bar-Hillel, M., Peer, E., & Acquisti, A. (2014). "Heads or tails?"—A reachability bias in binary choice. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *40*(6), 1656.
Barlas, Z. (2016). *The Influence of Freedom and Choice in Action Selection and the Valence of Action-outcomes on the Sense of Agency*. https://scholars.wlu.ca/etd/1852/
Barlas, Z., & Obhi, S. S. (2013). Freedom, choice, and the sense of agency. *Frontiers in Human Neuroscience*, *7*, 514.
Barlow, S. (2016, March). *Making "Her Story" - Telling a Story Using The Player's Imagination*. https://www.gdcvault.com/play/1023430/Making-Her-Story-Telling-a
Barthes, R. (2001). The death of the author. *Contributions in Philosophy*, *83*, 3–8.
Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research*, *1*(1), 19.
Bartle, R. (2005). *Virtual worlds: Why people play massively multiplayer game development*.
Bartle, R. (2004). *Designing Virtual Worlds*. New Riders.
Barto, A., Mirolli, M., & Baldassarre, G. (2013). Novelty or surprise? *Frontiers in Psychology*, *4*, 907.
Bartsch, A. (2012). Emotional Gratification in Entertainment Experience. Why Viewers of Movies and Television Series Find it Rewarding to Experience Emotions. *Media Psychology*, *15*(3), 267–302.
Bateman, C. (2008). *Roger Caillois' patterns of play*.
Bateman, C. (2009). *Beyond Game Design: Nine Steps Toward Creating Better Videogames*. Cengage Learning.
Bateman, C., & Nacke, L. E. (2010). The neurobiology of play. *Proceedings of the International Academic Conference on the Future of Game Design and Technology*, 1–8.
Baumeister, R. F. (2005). *The Cultural Animal: Human Nature, Meaning, and Social Life*. Oxford University Press.
Baumeister, R. F. (2016). Toward a general theory of motivation: Problems, challenges, opportunities, and the big picture. *Motivation and Emotion*, *40*(1), 1–10.
Baumgart, D. (2011). *Gameplay as a Hierarchy of Cycles | Gaslamp Games*. https://www.gaslampgames.com/2011/01/23/gameplay-as-a-hierarchy-of-cycles/
Beck, J., & Ekbia, H. R. (2018). The theory-practice gap as generative metaphor. *Proceedings of the 2018 CHI Conference on Human*. https://dl.acm.org/doi/abs/10.1145/3173574.3174194?casa_token=wdO25taFnj8AAAAA:8p11nGtqKE9NJBFFYg4_aFWN3xDSRpB_a4dVtz5zFW8-WIRgvQQ5d2nUGUIrVUIkToh3OoZhBs-8
Berlyne, D. E. (1950). Novelty and curiosity as determinants of exploratory behaviour. *British Journal of Psychology* , *41*(1), 68.
Berlyne, D. E. (1954). An experimental study of human curiosity. *British Journal of Psychology* , *45*(4), 256–265.
Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. 11164–11000.

Berlyne, D. E. (1962). Uncertainty and epistemic curiosity. *British Journal of Psychology* , *53*, 27–34.
Berlyne, D. E. (1971). *Aesthetics and psychology*.
Berlyne, D. E. (1978). Curiosity and learning. *Motivation and Emotion*, *2*(2), 97–175.
Berlyne, D. E., & Frommer, F. D. (1966). Some Determinants of the Incidence and Content of Children's Questions. *Child Development*, *37*(1), 177–189.
Binet, A. (1894). La psychologie de la prestidigitation. *Revue Des Deux Mondes* , *125*(4), 903–922.
Birk, M. V., Iacovides, I., Johnson, D., & Mandryk, R. L. (2015). The False Dichotomy between Positive and Negative Affect in Game Play. *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, 799–804.
Blanco, F., Matute, H., & Vadillo, M. A. (2011). Making the Uncontrollable Seem Controllable: the Role of Action in the Illusion of Control. *Quarterly Journal of Experimental Psychology*, *64*(7), 1290–1304.
Blizzard Entertainment. (2014). *Hearthstone*. Blizzard Entertainment.
Blythe, M. A., Overbeeke, K., Monk, A. F., & Wright, P. C. (2006). *Funology: From Usability to Enjoyment*. Springer Science & Business Media.
Bødker, S. (2015). Third-wave HCI, 10 years later---participation and sharing. *Interactions*, *22*(5), 24–31.
Bogost, I. (2016). *Play anything: The pleasure of limits, the uses of boredom, and the secret of games*. Basic Books.
Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: capturing life as it is lived. *Annual Review of Psychology*, *54*, 579–616.
Bolles, R. C. (1980). Some functionalistic thoughts about regulation. *Analysis of Motivational Processes*, 63–75.
Boll, S., Schmidt, A., Kern, D., Streng, S., & Holleis, P. (2008). Magic Beyond the Screen. *IEEE Multimedia*, *15*(4), 8–13.
Bonte, B. (2015). *tap tap tap*. Bart Bonte.
Bopp, J. A., Mekler, E. D., & Opwis, K. (2015). "It Was Sad But Still Good": Gratifications of Emotionally Moving Game Experiences. *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, 1193–1198.
Bopp, J. A., Opwis, K., & Mekler, E. D. (2018). "An Odd Kind of Pleasure": Differentiating Emotional Challenge in Digital Games. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–12.
Bortnik, M., Curley, V. H., Jen, J. H.-K., Macauley, J. D., Chen, L. T., & Lamb, S. D. (2011). Game achievements system (USPTO Patent No. 7887419). In *US Patent* (No. 7887419). https://patentimages.storage.googleapis.com/8e/13/25/c5c69c2fcb156f/US7887419.pdf
Bottoms, H. C., Eslick, A. N., & Marsh, E. J. (2010). Memory and the Moses illusion: failures to detect contradictions with stored knowledge yield negative memorial consequences. *Memory* , *18*(6), 670–678.
Boykin, A. W., & Harackiewicz, J. (1981). Epistemic curiosity and incidental recognition in relation to degree of uncertainty: Some general trends and intersubject differences. *British Journal of Psychology* , *72*(1), 65–72.
Boyle, C. (2019). *Simon Tatham's Puzzles*. Chris Boyle.
Bradley, M. M., & Lang, P. J. (2007). Emotion and motivation. *Handbook of Psychophysiology., 3rd Ed.*, *3*, 581–607.
Brod, G., Hasselhorn, M., & Bunge, S. A. (2018). When generating a prediction boosts learning: The element of surprise. *Learning and Instruction*, *55*, 22–31.
Brown, D. (2007). *Tricks of the Mind*. Random House.

Brown, D. (2014, January 8). *A Toy's Story - How To Control The Nation*. Channel 4. https://www.youtube.com/watch?v=EchfO2pjOrM

Brun, G., Kuenzle, D., & Doguoglu, U. (2008). *Introduction: A new role for emotions in epistemology?* https://www.zora.uzh.ch/id/eprint/11071/1/Brun-Kuenzle-EE-IntroV2.pdf

Brunstein, J. C., & Maier, G. W. (2005). Implicit and self-attributed motives to achieve: two separate but interacting needs. *Journal of Personality and Social Psychology*, *89*(2), 205–222.

Buchenau, M., & Suri, J. F. (2000). Experience prototyping. *Proceedings of the 3rd Conference on Designing*. https://dl.acm.org/doi/abs/10.1145/347642.347802?casa_token=3mbKnX0RPLkAAAAA:_u4GRhJWwawU2Q5I2EXereKHRz8WYYdIbO-t9iZ4o-MNGeTOAmHNQzz1mdNvNZvQypE5He9TdZ-1

Buie, E. A., Dray, S. M., Instone, K. E., Jain, J., Lindgaard, G., & Lund, A. M. (2010). Researcher-practitioner interaction. *CHI '10 Extended Abstracts on Human Factors in Computing Systems*, 4469–4472.

Bullfrog Productions. (1995). *Hi Octane*. Electronic Arts.

Caillois, R. (2001). Man, games, and play. *Trans. Meyer Barash. Chicago: University of Illinois Press*.

Caillois, R. (2006). The definition of play and the classification of games. *The Game Design Reader: A Rules of Play Anthology*, *122*.

Cairns, P., & Cox, A. L. (2008). *Research Methods for Human-Computer Interaction*. Cambridge University Press.

Cairns, P., Cox, A., & Nordin, A. I. (2014). Immersion in digital games: review of gaming experience research. *Handbook of Digital Games*, *1*, 767.

Calleja, G. (2011). *In-Game: From Immersion to Incorporation* (pp. 55-64). MIT Press.

Cardona-Rivera, R., Robertson, J., Ware, S., Harrison, B., Roberts, D., & Young, R. (2014). Foreseeing meaningful choices. *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, *10*. https://ojs.aaai.org/index.php/AIIDE/article/view/12716

Carroll, J. M., & Thomas, J. C. (1988). FUN. *SIGCHI Bull.*, *19*(3), 21–24.

Carroll, L. (1992). *Alice in Wonderland*. Wordsworth Editions.

Carruthers, P. (2017). Are epistemic emotions metacognitive? *Philosophical Psychology*, *30*(1-2), 58–78.

Cavanagh, T. (2012). *Super Hexagon*. Terry Cavanagh.

Cavazza, M., Lugrin, J., & Buehner, M. (2007). Causal Perception in Virtual Reality and its Implications for Presence Factors. *Presence* , *16*(6), 623–642.

Chae, B., & Hoegg, J. (2013). The Future Looks "Right": Effects of the Horizontal Location of Advertising Images on Product Attitude. *The Journal of Consumer Research*, *40*(2), 223–238.

Chambon, V., Sidarus, N., & Haggard, P. (2014). From action intentions to action effects: how does the sense of agency come about? *Frontiers in Human Neuroscience*, *8*, 320.

Charmaz, K. (2014). *Constructing Grounded Theory*. Sage.

Cheng, K. W. (2011). Casual gaming. *VU Amsterdam*. http://www.cs.vu.nl/~eliens/study/research/multimedia/imm/college/@archive/student/ba-CS/casual-games.pdf

Chen, J. (2007). Flow in games (and everything else). *Communications of the ACM*, *50*(4), 31–34.

Chen, J. (2013, April 5). *GDC 2013: Designing Journey | Adventure Gamers*. GDC Vault. https://www.gdcvault.com/browse/gdc-13/play/1017700

Chmielarz, A. (2012, November 8). *Why we need to kill gameplay to make better games*. The Astronauts. http://www.theastronauts.com/2012/11/why-we-need-to-kill-gameplay-to-make-better-games/
Christenfeld, N. (1995). Choices from Identical Options. *Psychological Science*, *6*(1), 50–55.
Christopher, M. (1996). *The illustrated history of magic*. Heinemann Educational Publishers.
Church, D. (1999, July 16). *Formal Abstract Design Tools*. Gamasutra. https://www.gamasutra.com/view/feature/131764/formal_abstract_design_tools.php
Clarke, A. C. (1973). *Profiles of the Future: An Inquiry Into the Limits of the Possible*. Pan Books.
Clover Studio. (2006). *Okami*. Capcom.
Cofer, C. N., & Appley, M. H. (1964). *Motivation: Theory and research*. *958*. https://psycnet.apa.org/fulltext/1965-00197-000.pdf
Cole, T., Cairns, P., & Gillies, M. (2015). Emotional and Functional Challenge in Core and Avant-garde Games. *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, 121–126.
Colusso, L., Bennett, C. L., & Hsieh, G. (2017). Translational resources: Reducing the gap between academic research and HCI practice. *Proceedings of the 2017*. https://dl.acm.org/doi/abs/10.1145/3064663.3064667?casa_token=JjQczFbQQkYAAAAA:QahWdZTfcEPmSX7xMvOp7fnA4h-38FpX8L_AL-5AB2wQZIN8VZ00hG0xaWPDfHQpnts__o8GmnYr
Colusso, L., Jones, R., Munson, S. A., & Hsieh, G. (2019). A Translational Science Model for HCI. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–13.
Company, F. (2017). *Picross Luna - A forgotten tale*. Floralmong company.
Corp., G. H. (2015). *Tap Tycoon*. Game Hive Corp.
Costikyan, G. (2013). *Uncertainty in Games*. MIT Press.
Cowley, B., Charles, D., Black, M., & Hickey, R. (2008). Toward an understanding of flow in video games. *Comput. Entertain.*, *6*(2), 1–27.
Crawford, C. (1985). *Balance of Power*. Mindscape.
Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. Harper Perennial.
Csikszentmihalyi, M. (2013). *Flow: The Psychology of Happiness*. Random House.
Csikszentmihalyi, M., Abuhamdeh, S., & Nakamura, J. (2014). *Flow and the Foundations of Positive Psychology*. Springer, Netherlands.
Danek, A. H., Öllinger, M., Fraps, T., Grothe, B., & Flanagin, V. L. (2015). An fMRI investigation of expectation violation in magic tricks. *Frontiers in Psychology*, *6*, 84.
Davis, D. K., & Abrams, L. (2016). Here's looking at you: Visual similarity exacerbates the Moses illusion for semantically similar celebrities. In *Journal of Experimental Psychology: Learning, Memory, and Cognition* (Vol. 42, Issue 1, pp. 75–90). https://doi.org/10.1037/xlm0000144
Dayan, E., Bar-Hillel, M., & Others. (2011). Nudge to nobesity II: Menu positions influence food orders. *Judgment and Decision Making*, *6*(4), 333–342.
Deci, E. L., & Flaste, R. (1995). *Why we do what we do: Understanding self-motivation*. Penguins Books.
Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*(6), 627–668; discussion 692–700.

Deci, E. L., & Ryan, R. M. (1980). Self-determination Theory: When Mind Mediates Behavior. *The Journal of Mind and Behavior*, *1*(1), 33–43.
Deci, E. L., & Ryan, R. M. (1985). *Causality Orientations Theory* (pp. 149–175). Springer US.
Deci, E. L., & Ryan, R. M. (2000). The“ what” and“ why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268.
Deci, E. L., & Ryan, R. M. (2010). Intrinsic Motivation. In I. B. Weiner & W. E. Craighead (Eds.), *The Corsini Encyclopedia of Psychology* (Vol. 125, p. 627). John Wiley & Sons, Inc.
DeKoven, B. (2002). *The well-played game: a playful path to wholeness*. iUniverse.
Denisova, A., Guckelsberger, C., & Zendle, D. (2017). Challenge in Digital Games: Towards Developing a Measurement Tool. *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 2511–2519.
Denisova, A., Nordin, A. I., & Cairns, P. (2016). The Convergence of Player Experience Questionnaires. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 33–37.
Department, N. C. (1985). *Super Mario Bros.* Nintendo.
Desurvire, H., Nacke, L., & Drachen, A. (2012). Game user research. *CHI'12 Extended*. https://dl.acm.org/doi/abs/10.1145/2212776.2212694?casa_token=0rtmiTwNVSwAAAAA:jos8salnuL9mZepeNW1zdoras8Ldd0InozpBskDrB6oppJG1GWuQTrp4rFtVDRkfDKBYtfu0luoT
Deterding, S. (2016). Contextual autonomy support in video game play: a grounded theory. *Proceedings of the 2016 CHI Conference on Human*. https://dl.acm.org/doi/abs/10.1145/2858036.2858395?casa_token=9uP0UMW9qlgAAAAA:G58hHVnmkmsXxd8lFYXaxIuWhoG16_yM6ByJ-vBYVfp_OcDSnCkgRGH5I-MReZfTrfPYuUiDrhOQ
Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining“ gamification.” *Proceedings of the 15th*. https://dl.acm.org/doi/abs/10.1145/2181037.2181040?casa_token=qodGFEbfSu8AAAAA:q5BGuMXOId1-Hy-m9H-HJw-yho7LXkR66iZIHEFOzUJMqPLyMGrZy_mRJBLNmq3ibNPz5Uopwa2E
Develop Conference. (2020, April 29). *Why Game Designers Should Study Stage Magic with Shringi Kumari | Develop:Brighton*. Youtube. https://www.youtube.com/watch?v=rMn1T8mQfjI
Dewey, J. (1913). *Interest and effort in education*. Forgotten Books.
Dewey, J. A., & Knoblich, G. (2014). Do implicit and explicit measures of the sense of agency measure the same thing? *PloS One*, *9*(10), e110118.
Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. *Educational Technology Research and Development: ETR & D*, *53*(2), 67–83.
Dix, A., Dix, A. J., Finlay, J., Abowd, G. D., & Beale, R. (2003). *Human-computer Interaction*. Pearson Education.
D'Mello, S., Lehman, B., Pekrun, R., & Graesser, A. (2014). Confusion can be beneficial for learning. *Learning and Instruction*, *29*, 153–170.
Dole, J. A., & Sinatra, G. M. (1998). Reconceptalizing change in the cognitive construction of knowledge. *Educational Psychologist*, *33*(2-3), 109–128.
Donlan, C. (2015, October 5). *"A compelling, impossible thing": Where magic and video games converge*. Eurogamer.net. http://www.eurogamer.net/articles/2015-05-10-a-compelling-impossible-thing-where-magic-and-video-games-converge
Dontnod Entertainment. (2015). *Life is Strange*. Square Enix.

Drachen, A., Canossa, A., & Yannakakis, G. N. (2009). Player modeling using self-organization in Tomb Raider: Underworld. *2009 IEEE Symposium on Computational Intelligence and Games*, 1–8.
Elsdon, M. (2014). *Equivoque Mark Elsdon Magic Tricks*. https://www.penguinmagic.com/tricks/tagged/equivoque+mark-elsdon
Ely, J., Frankel, A., & Kamenica, E. (2015). Suspense and Surprise. *The Journal of Political Economy*, *123*(1), 215–260.
Endress, S. I., Mekler, E. D., & Opwis, K. (2016). " It's Like I Would Die as Well" Gratifications of Fearful Game Experience. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, 149–155.
Entertainment, B. (2014). *Hearthstone*. Blizzard Entertainment.
Entertainment, R. (2001). *Max Payne*. Gathering of Developers.
Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers: A Journal of the Psychonomic Society, Inc*, *28*(1), 1–11.
Erickson, T. D., & Mattson, M. E. (1981). From words to meaning: A semantic illusion. *Journal of Verbal Learning and Verbal Behavior*, *20*(5), 540–551.
Escher, M. C. (2000). *M. C. Escher: The Graphic Work*. Taschen.
EuropeOG. (2015, May 26). *moment to moment gameplay*. NeoGAF. https://www.neogaf.com/threads/moment-to-moment-gameplay.1052193/
Extra Credits. (2012, May 19). *Playtesting - How to Get Good Feedback on Your Game - Extra Credits*. Youtube. https://www.youtube.com/watch?v=on7endO4lPY
Feep, C. (2011). *Where's My Water?* Disney Mobile.
Fendt, M. W., Harrison, B., Ware, S. G., Cardona-Rivera, R. E., & Roberts, D. L. (2012). *Achieving the Illusion of Agency: 5th International Conference, ICIDS 2012, San Sebastián, Spain, November 12-15, 2012. Proceedings* (D. Oyarzun, F. Peinado, R. M. Young, A. Elizalde, & G. Méndez (eds.); Vol. 7648, pp. 114–125). Springer Berlin Heidelberg.
Figueiredo, R., & Paiva, A. (2010). "I Want to Slay That Dragon!" - Influencing Choice in Interactive Storytelling. *Interactive Storytelling*, 26–37.
Findling, D. (2018, February 11). *The designer of "Monument Valley" has a new game where users explore relationships, without prizes or big thrills*. CNBC; CNBC. https://www.cnbc.com/2018/02/09/designer-of-monument-valley-has-a-new-game-where-users-explore-relationships.html
Fireproof Games. (2012). *The Room*. Fireproof Games.
Flick, U. (2000). Episodic interviewing. *Qualitative Researching with Text, Image and Sound*, 75–92.
Foddy, B. (2008). *QWOP*. Noodlecake Studios.
Fokkinga, S., & Desmet, P. (2012). Darker Shades of Joy: The Role of Negative Emotion in Rich Product Experiences. *Design Issues*, *28*(4), 42–56.
Fowler, H. (1965). *Curiosity and exploratory behavior*. The Macmillan Company.
Freeman, N. (2015). *Cibele*. Star Maid Games.
Frogmind Games. (2013). *Badland*. Frogmind Games.
Frost, R. (1921). *Mountain interval*. H. Holt.
Fullerton, T., Swain, C., & Hoffman, S. (2004). *Game Design Workshop: Designing, Prototyping, & Playtesting Games*. CRC Press.
Gallagher, I., I. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14–21.
GameHappens. (2019, September 19). *Why Game Designers should Study Stage Magic*. Game Happens. https://gamehappens.com/gh2019/shringi-kumari/

Gamekult. (2019, November 13). *In Dev With - Rencontre avec Shringi Kumari, magicienne du game design*. Gamekult. https://www.gamekult.com/emission/rencontre-avec-shringi-kumari-magicienne-du-game-design-3050822971.html
Games, J. B. (2018). *Pirate Kings*. Jelly Button Games.
Games, M. (2018). *Merge Plane*. Merger Games.
Games Now! (2016, September 1). *Stuart Nolan: Games and Magic - Aalto University Games Now! -lecture series*. Youtube. https://www.youtube.com/watch?v=oJ-V4UA-R40
Games, T. L. (2015). *Jotun*. Thunder Lotus Games.
Games, U. (2014, April). *Monument Valley out now*. Ustwo. https://www.ustwo.com/blog/monument-valley-out-now
Garfield, R. (1993). *Magic: The Gathering*. Wizards of the Coast.
Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming*, *33*(4), 441–467.
Gerrig, R. J. (1989). Suspense in the absence of uncertainty. *Journal of Memory and Language*, *28*(6), 633–648.
Goldberg, J. (2020, March). *The Science of Magic*. The International Brotherhood of Magicians. https://www.magician.org/the-linking-ring/what-is-the-linking-ring
Goldberg, L. R. (1992). The development of markers for the Big-Five factor structure. *Psychological Assessment*, *4*(1), 26–42.
Goldstein, P. (1996). *Verbal Control: A Treatise on the Under-exposed Art of Equivoque*. Philip T. Goldstein.
Golman, R., Loewenstein, G., & Gurney, N. (2015). Information Gaps for Risk and Ambiguity. *Available at SSRN 2605495*. https://doi.org/10.2139/ssrn.2605495
Goodman, E., Stolterman, E., & Wakkary, R. (2011). Understanding interaction design practices. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1061–1070.
Gottlieb, J., Oudeyer, P.-Y., Lopes, M., & Baranes, A. (2013). Information-seeking, curiosity, and attention: computational and neural mechanisms. *Trends in Cognitive Sciences*, *17*(11), 585–593.
Gray, C. M., Stolterman, E., & Siegel, M. A. (2014). Reprioritizing the relationship between HCI research and practice: bubble-up and trickle-down effects. *Proceedings of the 2014 Conference*. https://dl.acm.org/doi/abs/10.1145/2598510.2598595?casa_token=bd9lo7cF3MoAAAAA:08nvAJCOqmE1uYhxGq6rTizo7yAE1gDZ9qXHJYCcsKc3c2FnfyAT5yZtCOAZ6JUTcNUShV_HzJJb
Greenberger, E., Woldman, J., & Yourshaw, S. W. (1967). Components of curiosity: Berlyne reconsidered. *British Journal of Psychology* , *58*(3), 375–386.
Guest, G., Bunce, A., & Johnson, L. (2006). How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. *Field Methods*, *18*(1), 59–82.
Gunnell, K. E., Crocker, P. R. E., Wilson, P. M., Mack, D. E., & Zumbo, B. D. (2013). Psychological need satisfaction and thwarting: A test of Basic Psychological Needs Theory in physical activity contexts. *Psychology of Sport and Exercise*, *14*(5), 599–607.
Hagen, U. (2011). Designing for player experience: How professional game developers communicate design visions. *Journal of Gaming & Virtual Worlds*, *3*(3), 259–275.
Haggard, P. (2017). Sense of agency in the human brain. *Nature Reviews. Neuroscience*, *18*(4), 196–207.
Haggard, P., & Chambon, V. (2012). Sense of agency. *Current Biology: CB*, *22*(10), R390–R392.

Haggard, P., & Tsakiris, M. (2009). The Experience of Agency: Feelings, Judgments, and Responsibility. *Current Directions in Psychological Science*, *18*(4), 242–246.
Harrell, D. F., & Zhu, J. (2009). Agency Play: Dimensions of Agency for Interactive Narrative Design. *AAAI Spring Symposium: Intelligent Narrative Technologies II*, 44–52.
Harviainen, J. T., & Lieberoth, A. (2012). Similarity of social information processes in games and rituals: Magical interfaces. *Simulation & Gaming*, *43*(4), 528-549.
Hall, L., & Johansson, P. (2008). Using choice blindness to study decision making and introspection. *Cognition--A Smorgasbord, Ed. P. Gärdenfors & A. Wallin*, 267–283.
Hall, L., Johansson, P., Tärning, B., Sikström, S., & Deutgen, T. (2010). Magic at the marketplace: Choice blindness for the taste of jam and the smell of tea. *Cognition*, *117*(1), 54–61.
Hall, L., Strandberg, T., Pärnamets, P., Lind, A., Tärning, B., & Johansson, P. (2013). How the polls can be both spot on and dead wrong: using choice blindness to shift political attitudes and voter intentions. *PloS One*, *8*(4), e60554.
Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification. *2014 47th Hawaii International Conference on System Sciences*, 3025–3034.
Hamari, J., & Tuunanen, J. (2014). *Player types: A meta-synthesis*. https://tampub.uta.fi/bitstream/handle/10024/99064/player_types_a_meta_synthesis.pdf?sequence=1
Hardy, J. H., Ness, A. M., & Mecca, J. (2017). Outside the box: Epistemic curiosity as a predictor of creative problem solving and creative performance. *Personality and Individual Differences*, *104*, 230–237.
Hassenzahl, M. (2010). Experience Design: Technology for All the Right Reasons. *Synthesis Lectures on Human-Centered Informatics*, *3*(1), 1–95.
Hidi, S., & Renninger, K. A. (2006). The Four-Phase Model of Interest Development. *Educational Psychologist*, *41*(2), 111–127.
Hodent, C. (2017). *The Gamer's Brain: How Neuroscience and UX Can Impact Video Game Design*. CRC Press.
Hoeken, H., & van Vliet, M. (2000). Suspense, curiosity, and surprise: How discourse structure influences the affective and cognitive processing of a story. *Poetics* , *27*(4), 277–286.
Hookway, C. (2002). 13 Emotions and epistemic evaluations. *The Cognitive Basis of Science*, 251.
Howard, J. (2014). *Game Magic: A Designer's Guide to Magic Systems in Theory and Practice*. CRC Press.
Howard-Jones, P. A., & Demetriou, S. (2008). Uncertainty and engagement with learning games. *Instructional Science*, *37*(6), 519.
Hume, D. (2003). *A Treatise of Human Nature*. Courier Corporation.
Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. *Proceedings of the AAAI Workshop on Challenges in Game AI*, *4*, 1722.
Iacovides, I., Aczel, J. C., Scanlon, E., & Woods, W. I. S. (2011). What can breakdowns and breakthroughs tell us about learning and involvement experienced during game-play. *Proceedings of the 5th European Conference on Games Based Learning*, 275–281.
Iacovides, I., Cox, A. L., McAndrew, P., Aczel, J., & Scanlon, E. (2015). Game-Play Breakdowns and Breakthroughs: Exploring the Relationship Between Action, Understanding, and Involvement. *Human–Computer Interaction*, *30*(3-4), 202–231.
Inan, I. (2013). *The Philosophy of Curiosity*. Routledge.

IndieCade Europe. (2019a, November 20). *IN DEV WITH: SHRINGI KUMARI - IndieCade Europe 2019 X Gamekult*. Youtube. https://www.youtube.com/watch?v=E4PpZZ4CVA4

IndieCade Europe. (2019b, December 17). *Why Game Designers Should Study Stage Magic - a talk by Shringi Kumari at Indiecade Europe 2019*. Youtube. https://www.youtube.com/watch?v=TTJrzs92YZ0

Ip, B., & Jacobs, G. (2005). Segmentation of the games market using multivariate analysis. *Journal of Targeting, Measurement and Analysis for Marketing*, *13*(3), 275–287.

Itti, L., & Baldi, P. F. (2006). Bayesian Surprise Attracts Human Attention. In Y. Weiss, B. Schölkopf, & J. C. Platt (Eds.), *Advances in Neural Information Processing Systems 18* (pp. 547–554). MIT Press.

Jahoda, G. (1969). *The Psychology of Superstition*. Penguin Books, Limited.

James, W., & BF. (1918). *The Principles of Psychology (1918)*. Dover Publications.

Jansz, J. (2005). The Emotional Appeal of Violent Video Games for Adolescent Males. *Communication Theory: CT: A Journal of the International Communication Association*, *15*(3), 219–241.

Jenkins, S. R. (1987). Need for achievement and women's careers over 14 years: evidence for occupational structure effects. *Journal of Personality and Social Psychology*, *53*(5), 922–932.

Jirout, J., & Klahr, D. (2011). Children's Question Asking and Curiosity: A Training Study. *Society for Research on Educational Effectiveness*. https://eric.ed.gov/?id=ED528504

Johansson, P., Hall, L., & Sikström, S. (2008). From change blindness to choice blindness. *Psychologia; an International Journal of Psychology in the Orient*, *51*(2), 142–155.

Johansson, P., Hall, L., Sikström, S., & Olsson, A. (2005). Failure to detect mismatches between intention and outcome in a simple decision task. *Science*, *310*(5745), 116–119.

Johansson, P., Hall, L., Sikström, S., Tärning, B., & Lind, A. (2006). How something can be said about telling more than we can know: On choice blindness and introspection. *Consciousness and Cognition*, *15*(4), 673–692.

Johnson, M. R. (2018). *The Unpredictability of Gameplay*. Bloomsbury Academic.

Jones, L. (2004). *Encyclopedia of Impromptu Card Forces: 500 Forces with a Borrowed Deck*. Lewis Jones.

Jorgensen, A. H. (2004). Marrying HCI/Usability and computer games: a preliminary look. *Proceedings of the Third Nordic Conference on Human-Computer Interaction - NordiCHI '04*, 393–396.

Juul, J. (2010a). *A Casual Revolution: Reinventing Video Games and Their Players*. MIT Press.

Juul, J. (2010b). *The Game, the Player, the World: Looking for a Heart of Gameness*. https://www.jesperjuul.net/text/gameplayerworld/

Juul, J. (2011). *Half-Real: Video Games between Real Rules and Fictional Worlds*. MIT Press.

Juul, J. (2018, August 15). *The Aesthetics of the Aesthetics of the Aesthetics of Video Games*. Jesper Juul. https://www.jesperjuul.net/text/aesthetics3/

Kagan, J. (1972). Motives and development. In *Journal of Personality and Social Psychology* (Vol. 22, Issue 1, pp. 51–66). https://doi.org/10.1037/h0032356

Kahneman, D. (2002). Maps of bounded rationality: A perspective on intuitive judgment and choice. *Nobel Prize Lecture*, *8*, 351–401.

Kallio, K. P., Mäyrä, F., & Kaipainen, K. (2011). At Least Nine Ways to Play: Approaching Gamer Mentalities. *Games and Culture*, *6*(4), 327–353.

Kamin, L. J. (1967). *Predictability, surprise, attention, and conditioning*. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19680014821.pdf
Kang, M. J., Hsu, M., Krajbich, I. M., Loewenstein, G., McClure, S. M., Wang, J. T.-Y., & Camerer, C. F. (2009). The wick in the candle of learning: epistemic curiosity activates reward circuitry and enhances memory. *Psychological Science*, *20*(8), 963–973.
Karsh, N., & Eitam, B. (2015). Motivation from control: A response selection framework. *The Sense of Agency. New York, NY: Oxford University Press. Https://doi.org/10. 1093/acprof: oso/9780190267278. 003*, *12*.
Kashdan, T. B., & Roberts, J. E. (2004). Trait and State Curiosity in the Genesis of Intimacy: Differentiation From Related Constructs. *Journal of Social and Clinical Psychology*, *23*(6), 792–816.
Kashdan, T. B., & Silvia, P. J. (2009). Curiosity and interest: The benefits of thriving on novelty and challenge. *Oxford Handbook of Positive Psychology*, *2*, 367–374.
Kashdan, T. B., & Steger, M. F. (2007). Curiosity and pathways to well-being and meaning in life: Traits, states, and everyday behaviors. *Motivation and Emotion*, *31*(3), 159–173.
Keith, C. (2010). *Agile Game Development with Scrum*. Pearson Education.
Kelly, H. (1980). Magic tricks: The management of causal attributions. *Perspectives on Attribution Research and Theory: The Bielefeld Symposium*, 19–35.
Khajah, M. M., Roads, B. D., Lindsey, R. V., Liu, Y.-E., & Mozer, M. C. (2016). Designing Engaging Games Using Bayesian Optimization. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 5571–5582.
Kickstarter. (2015, July 27). *12 Questions on Game Design - Kickstarter Magazine - Medium*. https://medium.com/kickstarter/12-questions-on-game-design-ff994420de9d
Kiesel, S., Burns, E., & Ruml, W. (2015). Achieving Goals Quickly Using Real-time Search: Experimental Results in Video Games. *The Journal of Artificial Intelligence Research*, *54*, 123–158.
Kim, S. I. (2013). Neuroscientific Model of Motivational Process. In *Frontiers in Psychology* (Vol. 4). https://doi.org/10.3389/fpsyg.2013.00098
Kim, Y. B., & Lee, S. H. (2017). Mobile gamer's epistemic curiosity affecting continuous play intention. Focused on players' switching costs and epistemic curiosity. *Computers in Human Behavior*, *77*, 32–46.
King. (2012). *Candy Crush Saga*. King.
King. (2013). *Farm Heroes Saga*. King.
King. (2014). *Candy Crush Soda Saga*. King.
Kittens, E. (2015). *Exploding Kittens*. Exploding Kittens.
Kleon, A. (2012). *Steal Like an Artist: 10 Things Nobody Told You About Being Creative*. Workman Publishing.
Klimas, C. (2009). *Twine / An open-source tool for telling interactive, nonlinear stories*. Twine. https://twinery.org/
Klimmt, C. (2006). *Computerspielen als Handlung: Dimensionen und Determinanten des Erlebens interaktiver Unterhaltungsangebote*. Herbert von Halem Verlag.
Klimmt, C. (2008). Escapism. In *The International Encyclopedia of Communication* (Vol. 23, p. 243). Wiley Online Library.
Klimmt, C. (2003). Dimensions and determinants of the enjoyment of playing digital games: A three-level model. *Level up: Digital Games Research Conference*, 246–257.
Kolko, J. (2010). On academic knowledge production. In *interactions* (Vol. 17, Issue 5, p. 80). https://doi.org/10.1145/1836216.1836237
Koster, R. (2013). *Theory of Fun for Game Design*. "O'Reilly Media, Inc."

Koster, R. (2018). *The cost of games*. Gamasutra. https://www.gamasutra.com/blogs/RaphKoster/20180117/313211/The_cost_of_games.php
Kuhn, G. (2019). *Experiencing the Impossible*. https://doi.org/10.7551/mitpress/11227.001.0001
Kuhn, G., Amlani, A. A., & Rensink, R. A. (2008). Towards a science of magic. *Trends in Cognitive Sciences*, *12*(9), 349–354.
Kuhn, G., & Land, M. F. (2006). There's more to magic than meets the eye. *Current Biology: CB*, *16*(22), R950–R951.
Kuhn, G., Olson, J. A., & Raz, A. (2016). Editorial: The Psychology of Magic and the Magic of Psychology. In *Frontiers in Psychology* (Vol. 7). https://doi.org/10.3389/fpsyg.2016.01358
Kuhn, G., Pailhès, A., & Lan, Y. (2020). Forcing you to experience wonder: Unconsciously biasing people's choice through strategic physical positioning. *Consciousness and Cognition*, *80*, 102902.
Kuhn, G., & Rensink, R. A. (2016). The Vanishing Ball Illusion: A new perspective on the perception of dynamic events. *Cognition*, *148*, 64–70.
Kuhn, G., & Teszka, R. (2018). Don't get misdirected! Differences in overt and covert attentional inhibition between children and adults. *Quarterly Journal of Experimental Psychology* , *71*(3), 688–694.
Kultima, A. (2018). *Game design praxiology*. https://trepo.tuni.fi/handle/10024/103315
Kultima, A., & Karvinen, J. (2016). Idea practices and attitudes towards innovation in game development. In *Proceedings of the 20th International Academic Mindtrek Conference on - AcademicMindtrek '16*. https://doi.org/10.1145/2994310.2994359
Kumari, S., Deterding, C. S., & Kuhn, G. (2018, June 8). Why Game Designers Should Study Magic. *Foundations of Digital Games 2018 (FDG18)*. https://doi.org/10.1145/3235765.3235788
Kumari, S., Deterding, C. S., & Kuhn, G. (2019, July). Creating the illusion of free choice - How forcing can influence video game design. *Science of Magic Association 2019*. https://static1.squarespace.com/static/5853f730ebbd1abde9c9b087/t/5d2603e84de7da0001c619d2/1562772471552/SOMA19_Program_v7_web.pdf
Kumari, S., Deterding, S., & Freeman, J. (2019). The Role of Uncertainty in Moment-to-Moment Player Motivation: A Grounded Theory. *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 351–363.
Kumari, S., Power, C., & Cairns, P. (2017). Investigating Uncertainty in Digital Games and Its Impact on Player Immersion. *Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play*, 503–509.
Kyatric, I. (2013). Bartle's Taxonomy of Player Types (And Why It Doesn't Apply to Everything). *Retrieved from Website:* https://gamedevelopment.tutsplus.com/articles/bartles-taxonomy-of-player-types-and-why-it-doesnt-apply-to-everything--gamedev-4173
Landman, T. (2013). Framing performance magic: The role of contract, discourse and effect. *Journal of Performance Magic*. https://search.informit.com.au/documentSummary;dn=643998457442495;res=IELLCC
Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology*, *32*(2), 311–328.
Lanier, L. (2019, May 1). *Video Games Could Be a $300 Billion Industry by 2025 (Report)*. Variety. https://variety.com/2019/gaming/news/video-games-300-billion-industry-2025-report-1203202672/

Lan, Y., Mohr, C., Hu, X., & Kuhn, G. (2018). Fake science: The impact of pseudo-psychological demonstrations on people's beliefs in psychological principles. In *PLOS ONE* (Vol. 13, Issue 11, p. e0207629). https://doi.org/10.1371/journal.pone.0207629

Lazzaro, N. (2004). Why we play games: Four keys to more emotion without story. *Game Developer's Conference, San Jose*. http://www.xeodesign.com/whyweplaygames/xeodesign_whyweplaygames.pdf

LeBlanc, M. (2006). Tools for creating dramatic game dynamics. *The Game Design Reader: A Rules of Play Anthology*, 438–459.

Leterrier, L. (2013, May 31). *Now You See Me*. Summit Entertainment.

Lindley, C. A. (2005). Story and narrative structures in computer games. *Bushoff, Brunhild. Ed*. https://www.math.vu.nl/~eliens/create/local/story/sagasnetLindleyReprint.pdf

Litman, J. A. (2005). Curiosity and the pleasures of learning: Wanting and liking new information. *Cognition and Emotion*, *19*(6), 793–814.

Litman, J. A. (2008). Interest and deprivation factors of epistemic curiosity. *Personality and Individual Differences*, *44*(7), 1585–1595.

Litman, J. A., Crowson, H. M., & Kolinski, K. (2010). Validity of the Interest- and Deprivation-type epistemic curiosity distinction in non-students. In *Personality and Individual Differences* (Vol. 49, Issue 5, pp. 531–536). https://doi.org/10.1016/j.paid.2010.05.021

Litman, J. A., & Jimerson, T. L. (2004). The measurement of curiosity as a feeling of deprivation. *Journal of Personality Assessment*, *82*(2), 147–157.

Litman, J. A., & Mussel, P. (2013). Validity of the Interest-and Deprivation-Type Epistemic Curiosity Model in Germany. *Journal of Individual Differences*, *34*(2), 59–68.

Litman, J. A., Hutchins, T., & Russon, R. (2005). Epistemic curiosity, feeling-of-knowing, and exploratory behaviour. *Cognition & Emotion*. https://www.tandfonline.com/doi/abs/10.1080/02699930441000427?casa_token=HEPF8iisHyUAAAAA:0d4WMDzF1crYOxSNdD09OKkz7ypIv66TLeSIogq9nPX3uj2D43BAy0sdGDYA37kIUH8uXnLud5JSzg

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*. *413*. https://psycnet.apa.org/fulltext/1990-97846-000.pdf

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation. A 35-year odyssey. *The American Psychologist*, *57*(9), 705–717.

Loderer, K., Pekrun, R., & Plass, J. L. (2020). Emotional foundations of game-based learning. *Handbook of Game-Based Learning*, 111.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, *116*(1), 75–98.

Lomas, J. D., Koedinger, K., Patel, N., Shodhan, S., Poonwala, N., & Forlizzi, J. L. (2017). Is Difficulty Overrated? The Effects of Choice, Novelty and Suspense on Intrinsic Motivation in Educational Games. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 1028–1039.

Long, G. (2007). Transmedia storytelling. *Business, Aesthetics and Production at the Jim Henson Company. Degree of Master of Science in Comparative Media Studies at the Massachusetts Institute of Technology*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.618.1540&rep=rep1&type=pdf

Long, S. (2012). *Player Research ◐ Where gaming instinct meets scientific insight*. Player Research. https://www.playerresearch.com/

Lorini, E., & Castelfranchi, C. (2007). The cognitive structure of surprise: looking for basic principles. *Topoi. An International Review of Philosophy*, *26*(1), 133–149.
Luchins, A. S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs*, *54*(6), i.
Luton, W. (2009). *Gamasutra - Making Better Games Through Iteration*. Gamasutra. https://www.gamasutra.com/view/feature/132554/making_better_games_through_.php?print=1
Lynn, M. T., Berger, C. C., Riddle, T. A., & Morsella, E. (2010). Mind control? Creating illusory intentions through a phony brain–computer interface. *Consciousness and Cognition*, *19*(4), 1007–1012.
Macklin, C., & Sharp, J. (2016). *Games, Design and Play: A detailed approach to iterative game design*. Addison-Wesley Professional.
Macknik, S. L., King, M., Randi, J., Robbins, A., Teller, Thompson, J., & Martinez-Conde, S. (2008). Attention and awareness in stage magic: turning tricks into research. *Nature Reviews. Neuroscience*, *9*(11), 871–879.
Maheswaran, D., & Chaiken, S. (1991). Promoting systematic processing in low-motivation settings: effect of incongruent information on processing and judgment. *Journal of Personality and Social Psychology*, *61*(1), 13–25.
Malaby, T. M. (2007). Beyond Play: A New Approach to Games. *Games and Culture*, *2*(2), 95–113.
Mallon, B. (2008). Towards a taxonomy of perceived agency in narrative game-play. *Comput. Entertain.*, *5*(4), 1–15.
Malone, T. W. (1981). Toward a Theory of Intrinsically Motivating Instruction*. In *Cognitive Science* (Vol. 5, Issue 4, pp. 333–369). https://doi.org/10.1207/s15516709cog0504_2
Malone, T. W. (1982). Heuristics for designing enjoyable user interfaces: Lessons from computer games. *Proceedings of the 1982 Conference on Human Factors*. https://dl.acm.org/citation.cfm?id=801756
Malone, T. W. (1984). What makes computer games fun? Guidelines for designing educational computer programs. *Intelligent Schoolhouse*, 78–92.
Manthorpe, R. (2017, March 31). *Derren brown's vr ghost train is back – and this time it's actually scary*. Wired. http://www.wired.co.uk/article/derren-brown-vr-ghost-train-thorpe-park
Marczewski, A. (2013, March 26). *Feedback Loops, Gamification and Employee Motivation*. Gamasutra. https://www.gamasutra.com/blogs/AndrzejMarczewski/20130326/189284/Feedback_Loops_Gamification_and_Employee_Motivation.php
Marshall, J., Benford, S., & Pridmore, T. (2010). Deception and Magic in Collaborative Interaction. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 567–576.
Marsh, T., & Costello, B. (2012). Experience in Serious Games: Between Positive and Serious Experience. *Serious Games Development and Applications*, 255–267.
Marsh, T., & Costello, B. (2013). Lingering Serious Experience as Trigger to Raise Awareness, Encourage Reflection and Change Behavior. *Persuasive Technology*, 116–124.
Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, *50*(4), 370.
Marvin, C. B., & Shohamy, D. (2016). Curiosity and reward: Valence predicts choice and information prediction errors enhance learning. *Journal of Experimental Psychology. General*, *145*(3), 266–272.
Masciocchi, C. M., & Still, J. D. (2013). Alternatives to Eye Tracking for Predicting Stimulus-Driven Attentional Selection Within Interfaces. *Human–Computer*

Interaction, *28*(5), 417–441.
Mateas, M. (2001). A preliminary poetics for interactive drama and games. *Digital Creativity*, *12*(3), 140–152.
Matute, H., Blanco, F., Yarritu, I., Díaz-Lago, M., Vadillo, M. A., & Barberia, I. (2015). Illusions of causality: how they bias our everyday thinking and how they could be reduced. *Frontiers in Psychology*, *6*, 888.
Matute, H., Yarritu, I., & Vadillo, M. A. (2011). Illusions of causality at the heart of pseudoscience. *British Journal of Psychology* , *102*(3), 392–405.
Maven, M. (1992). *Max Maven's book of fortune telling*. Prentice Hall General Reference.
Maven, M. (2011). *Multiplicity by Max Maven (DVD)*. https://www.penguinmagic.com/p/2514
May, T. W. (2020, May 8). *The World's 2.7 Billion Gamers Will Spend 159.3 Billion on Games in 2020; The Market Will Surpass 200 Billion by 2023 | Newzoo*. Newzoo. https://newzoo.com/insights/articles/newzoo-games-market-numbers-revenues-and-audience-2020-2023/
McCloud, S. (1993). Understanding comics: The invisible art. *Northampton, Mass*. http://www.fil.lu.se/media/utbildning/dokument/kurser/TEK210/20132/TEK210_virtual_characters_student.pdf
McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality*, *60*(2), 175–215.
McEntee, C. (2012). *Rational design: the core of rayman origins*. Gamasutra. https://www.gamasutra.com/view/feature/167214/rational_design_the_core_of_.php
Mediocre. (2016). *PinOut*. Mediocre.
Meier, S. (2012). *Interesting Decisions*. GDC Vault. https://www.gdcvault.com/play/1015756/Interesting
Mekler, E. D., Rank, S., Steinemann, S. T., Birk, M. V., & Iacovides, I. (2016). Designing for Emotional Complexity in Games: The Interplay of Positive and Negative Affect. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, 367–371.
Menzel, J. (2016). Level Design Workshop: Solving Puzzle Design. *Workshop Presented at the Game Developers Conference (GDC 2016), San Francisco, CA, USA, March*, 14–18.
Metcalfe, J., Schwartz, B. L., & Bloom, P. A. (2017). The tip-of-the-tongue state and curiosity. *Cognitive Research: Principles and Implications*, *2*(1), 31.
Meylan, A. (2014). Epistemic Emotions: a Natural Kind? *Philosophical Inquiries*, *2*(1), 173–190.
Michaelian, K., & Arango-Muñoz, S. (2014). Epistemic Feelings, Epistemic Emotions: Review and Introduction to the Focus Section. *Philosophical Inquiries*, *2*(1), 97–122.
Michotte, A. (2017). *The Perception of Causality*. Routledge.
Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*. https://psycnet.apa.org/record/2004-16335-000
Miron-Shatz, T., Stone, A., & Kahneman, D. (2009). Memories of yesterday's emotions: does the valence of experience affect the memory-experience gap? *Emotion* , *9*(6), 885–891.
Mirza-Babaei, P., Long, S., Foley, E., & McAllister, G. (2011). *Understanding the Contribution of Biometrics to Games User Research*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.224.9755&rep=rep1&type=pdf
Mojang. (2011). *Minecraft*. Mojang.

Montola, M. (2010). The positive negative experience in extreme role-playing. *The Foundation Stone of Nordic Larp (2010)*, *153*. https://books.google.com/books?hl=en&lr=&id=gVsbBQAAQBAJ&oi=fnd&pg=PA153&dq=montola+xtreme+live++action++role-playing++unpleasant+(feeling+disgust+and+desperation)&ots=07Uicb20_h&sig=6SoYHbg9MvQLLsorljUZQZkFKNQ
Morton, A. (2010). Epistemic Emotions. In P. Goldie (Ed.), *The Oxford Handbook of Philosophy of Emotion* (pp. 385–399). Oxford University Press.
Mountains. (2018). *Florence*. Annapurna Interactive.
Mullich, D. (2016, January 18). *How Stage Magic Influenced My Career*. David Mullich. https://davidmullich.com/2016/01/18/how-magic-influenced-my-career/
Murray, J. H. (2017). *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. MIT Press.
Murthy, P. N. (2002). The user illusion: cutting consciousness down to size. By Tor Nørrentranders (translated by Jonathan Sydenham). Published by Penguin Books, New York, 1999, 480 pp., ISBN 0 140 23012 2, £10.99. *Systems Research: The Official Journal of the International Federation for Systems Research*, *19*(5), 509–512.
Mussel, P. (2010). Epistemic curiosity and related constructs: Lacking evidence of discriminant validity. *Personality and Individual Differences*, *49*(5), 506–510.
Myers, I. B. (1962). *The Myers-Briggs Type Indicator: Manual (1962)*. https://psycnet.apa.org/psycinfo/2013-29682-000/
Nacke, L. E., Bateman, C., & Mandryk, R. L. (2014). BrainHex: A neurobiological gamer typology survey. *Entertainment Computing*, *5*(1), 55–62.
Nakamura, J., & Csikszentmihalyi, M. (2009). Flow theory and research. *Handbook of Positive Psychology*, 195–206.
Namco. (2004). *Katamari Damacy*. Namco.
New York Film Academy. (2014, November 25). *How To Form A Solid Indie Game Development Team*. Student Resources. https://www.nyfa.edu/student-resources/forming-solid-indie-game-development-team/
Nguyen, R. (2017, October 25). *What Game Development Can Learn from Filmmaking*. With A Terrible Fate. https://withaterriblefate.com/2017/10/25/what-game-development-can-learn-from-filmmaking/
Nintendo EAD. (2014). *Mario Kart 8*. Nintendo.
Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, *84*(3), 231–259.
Nitsche, M. (2008). *Video Game Spaces: Image, Play, and Structure in 3D Worlds*. MIT Press.
Nordcurrent. (2014). *Cooking Fever*. Nordcurrent.
Norman, D. A. (2013). *The design of everyday things: Revised and expanded edition*. Basic books.
Norman, D. A. (2010). The research-practice gap: the need for translational developers. *Interactions*, *17*(4), 9–12.
Numinous Games. (2016). *That Dragon, Cancer*. Numinous Games.
Nyamyam. (2019). *Astrologaster*. Nyamyam.
Oliver, M. B., & Bartsch, A. (2011). Appreciation of Entertainment. *Journal of Media Psychology*, *23*(1), 29–33.
Oliver, M. B., Bowman, N. D., Woolley, J. K., Rogers, R., Sherrick, B. I., & Chung, M.-Y. (2016). Video games as meaningful entertainment experiences. *Psychology of Popular Media Culture*, *5*(4), 390–405.
Olson, J. A., Amlani, A. A., Raz, A., & Rensink, R. A. (2015). Influencing choice without

awareness. *Consciousness and Cognition*, *37*, 225–236.
Olson, J. A., Amlani, A. A., & Rensink, R. A. (2012). Perceptual and cognitive characteristics of common playing cards. *Perception*, *41*(3), 268–286.
Olson, J. A., Amlani, A., & Rensink, R. (2013). Using Magic to Influence Choice in the Absence of Visual Awareness. *Journal of Vision*, *13*(9), 1133–1133.
Ortiz, D. (1995). *Strong magic: Creative showmanship for the close-up magician*. R. Kaufman and A. Greenberg.
Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review*, *97*(3), 315–331.
Ozono, H. (2017). What kind of magician's choice is more effective? An experiment. *Science of Magica Association Conference, London.*
Ozono, H., Komiya, A., Kuratomi, K., Hatano, A., Fastrich, G. M., Raw, J., Haffey, A., Meliss, S., Lau, J. K. L., & Murayama, K. (2020). *Magic Curiosity Arousing Tricks (MagicCATs): A novel stimulus collection to induce epistemic emotions*. https://doi.org/10.31234/osf.io/qxdsn
Pailhès, A., & Kuhn, G. (2019). A psychologically-based taxonomy of magicians' forcing techniques. *Science of Magic Association Conference in Chicago*.
Pailhès, A., & Kuhn, G. (2020). The apparent action causation: Using a magician forcing technique to investigate our illusory sense of agency over the outcome of our choices. *The Quarterly Journal of Experimental Psychology*. http://research.gold.ac.uk/id/eprint/28419
Pailhès, A., & Kuhn, G. (2020). Influencing choices with conversational primes: How a magic trick unconsciously influences card choices. *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.2000682117
Pailhès, A., Kumari, S., & Kuhn, G. (2020). The Magician's Choice:Providing illusory choice and sense of agency with the Equivoque forcing technique. *Journal of Experimental Psychology*.
Parijat, S. (2017, January 29). *Call of Duty 2017 Maps Will Focus On Second To Second Experiences, Suggests Job Listing*. Gamingbolt. https://gamingbolt.com/call-of-duty-2017-maps-will-focus-on-second-to-second-experiences-suggests-job-listing
Park, N., Min Lee, K., Annie Jin, S.-A., & Kang, S. (2010). Effects of pre-game stories on feelings of presence and evaluation of computer games. *International Journal of Human-Computer Studies*, *68*(11), 822–833.
Parris, B. A., Kuhn, G., Mizon, G. A., Benattayallah, A., & Hodgson, T. L. (2009). Imaging the impossible: an fMRI study of impossible causal relationships in magic tricks. *NeuroImage*, *45*(3), 1033–1039.
Parsler, J. (2010). The non-player agent in computer role-playing games. *Journal of Gaming & Virtual Worlds*, *2*(2), 135–143.
Pekrun, R., & Linnenbrink-Garcia, L. (2014). *International Handbook of Emotions in Education*. Routledge.
Pekrun, R., Vogl, E., Muis, K. R., & Sinatra, G. M. (2017). Measuring emotions during epistemic activities: the Epistemically-Related Emotion Scales. *Cognition & Emotion*, *31*(6), 1268–1276.
Peng, W., Lin, J.-H., Pfeiffer, K. A., & Winn, B. (2012). Need Satisfaction Supportive Game Features as Motivational Determinants: An Experimental Study of a Self-Determination Theory Guided Exergame. *Media Psychology*, *15*(2), 175–196.
Penn Jillette, T. (2015, July 31). *Penn & Teller Fool Us - Coins & Fish Trick*. Fountain Studios. https://www.youtube.com/watch?v=9ByGtdqiUz8
Penton, T., Wang, X., Coll, M.-P., Catmur, C., & Bird, G. (2018). The influence of action–outcome contingency on motivation from control. *Experimental Brain*

Research. Experimentelle Hirnforschung. Experimentation Cerebrale, *236*(12), 3239–3249.
Pitkänen, J. (2015). Studying thoughts: Stimulated recall as a game research method. *Game Research Methods*, 117–132.
Playdead. (2010). *Limbo*. Microsoft Game Studios.
Playdemic. (2017). *Golf Clash*. Playdemic Ltd.
Playdots, I. (2014). *Two Dots*. Playdots, Inc.
PopCap Games. (2001). *Bejeweled*. PopCap Games.
PopCap Games. (2009). *Plants vs. Zombies*. Electronic Arts.
Pope, L. (2013). *Papers, Please*. 3909 LLC.
Power, C., Cairns, P., & Denisova, A. (2019). Lost at the edge of uncertainty: Measuring player uncertainty in digital games. *Journal of Human …*. https://www.tandfonline.com/doi/abs/10.1080/10447318.2018.1507161
Power, C., Denisova, A., Papaioannou, T., & Cairns, P. (2017). Measuring Uncertainty in Games: Design and Preliminary Validation. *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 2839–2845.
Presson, P. K., & Benassi, V. A. (1996). Illusion of control: A meta-analytic review. *Journal of Social Behavior and Personality*, *11*(3), 493.
Priest, C. (2006). *The Prestige*. Tom Doherty Associates.
Pritchard, M. (2019, September 30). *Shringi Kumari – magic, gaming, and poetry (#82)*. Words on Wonder. https://wordsonwonder.com/2019/09/30/shringi-kumari-magic-gaming-and-poetry-82/
Pro, I. (2015). *Kholat*. IMGN.PRO.
Prolific. (2020). *Prolific | Online participant recruitment for surveys and market research*. Prolific. https://www.prolific.co/
Przybylski, A. K., Rigby, S., & Ryan, R. (2010). A Motivational Model of Video Game Engagement. *Review of General Psychology: Journal of Division 1, of the American Psychological Association*, *14*(2), 154–166.
Przybylski, A. K., Weinstein, N., Murayama, K., Lynch, M. F., & Ryan, R. (2012). The ideal self at play: the appeal of video games that let you be all you can be. *Psychological Science*, *23*(1), 69–76.
Quantic Dream. (2010). *Heavy Rain*. Sony Computer Entertainment.
Ranganath, C., & Rainer, G. (2003). Neural mechanisms for detecting and remembering novel events. *Nature Reviews. Neuroscience*, *4*(3), 193–202.
Rasmussen, M. K. (2013). Magical Realities in Interaction Design. *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction*, 125–128.
Reeve, J. (2014). *Understanding Motivation and Emotion*. John Wiley & Sons.
Reeve, J. (2016). A grand theory of motivation: Why not? *Motivation and Emotion*, *40*(1), 31–35.
Reeve, J., & Cheon, S. H. (2014). An intervention-based program of research on teachers' motivating styles. *Advances in Motivation and Achievement*, *18*, 293–339.
Reeve, J., & Nix, G. (1997). Expressing Intrinsic Motivation Through Acts of Exploration and Facial Displays of Interest. *Motivation and Emotion*, *21*(3), 237–250.
Reeves, S., Benford, S., O'Malley, C., & Fraser, M. (2005). Designing the Spectator Experience. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 741–750.
Reinecke, L., & Oliver, M. B. (2016). *The Routledge Handbook of Media Use and Well-Being: International Perspectives on Theory and Research on Positive Media Effects*. Routledge.
Reinecke, L., Tamborini, R., Grizzard, M., Lewis, R., Eden, A., & David Bowman, N. (2012).

Characterizing Mood Management as Need Satisfaction: The Effects of Intrinsic Needs on Selective Exposure and Mood Repair. *The Journal of Communication*, *62*(3), 437–453.
Reisenzein, R. (2000). The subjective experience of surprise. *The Message within: The Role of Subjective Experience in Social Cognition and Behavior*, 262–279.
Remy, C., Gegenbauer, S., & Huang, E. M. (2015). Bridging the theory-practice gap: Lessons and challenges of applying the attachment framework for sustainable hci design. *Proceedings of the 33rd Annual*. https://dl.acm.org/doi/abs/10.1145/2702123.2702567?casa_token=0YwI7x5Hq3MAAAAA:EZtyo7kAk7oulGRAPxOufV-JG5dNLcIVq_wEK84IQydhMAUbQAULDb82waIyD-K9OFUQotJmpxSM
Rensink, R. A., & Kuhn, G. (2015). A framework for using magic to study the mind. *Frontiers in Psychology*, *5*, 1508.
Rescorla, R. A. (1972). A theory of Pavlovian conditioning : Variations in the effectiveness of reinforcement and nonreinforcement. *Current Research and Theory*, 64–99.
Rieznik, A., Moscovich, L., Frieiro, A., Figini, J., Catalano, R., Garrido, J. M., Álvarez Heduan, F., Sigman, M., & Gonzalez, P. A. (2017). A massive experiment on choice blindness in political decisions: Confidence, confabulation, and unconscious detection of self-deception. *PloS One*, *12*(2), e0171108.
Rigby, S., & Ryan, R. (2016). Motivation for entertainment media and its eudaimonic aspects through the lens of self-determination theory. *The Routledge Handbook of Media Use and Well-Being: International Perspectives on Theory and Research on Positive Media Effects*, 34–48.
Rigby, S., & Ryan, R. (2007). The Player Experience of Need Satisfaction (PENS): An applied model and methodology for understanding key components of the player experience. *Retrieved from Immersyve. com/PENS_Sept07. Pdf*.
Rigby, S., & Ryan, R. (2011). *Glued to Games: How Video Games Draw Us In and Hold Us Spellbound: How Video Games Draw Us In and Hold Us Spellbound*. ABC-CLIO.
Robert-Houdin, J. E. (1859). *Memoirs of Robert-Houdin, written by himself [tr. by sir F.C.L. Wraxall]. Copyright ed*.
Rodway, P., Schepman, A., & Thoma, V. (2016). Reachability Does Not Explain the Middle Preference: A Comment on Bar-Hillel (2015). *I-Perception*, *7*(2), 2041669516639959.
Rogers, E. M. (2010). *Diffusion of Innovations, 4th Edition*. Simon and Schuster.
Rogers, Y. (2012). HCI theory: classical, modern, and contemporary. Synthesis lectures on human-centered informatics, 5(2), 1-129.
Rohrl, D., Greechan, J., Lee, M., Robbins, B., Prigg, D., Gril, J., & Meretzky, S. (2008). 2009 Casual Games White Paper. *Retrieved December*, *6*, 2011.
Romero, B. (2011, January 13). *Design Truth 1*. Applied Game Design. https://bbrathwaite.wordpress.com/2011/01/13/design-truth-1/
Roster, C. A., Lucianetti, L., & Albaum, G. (2015). Exploring Slider vs. Categorical Response Formats in Web-Based Surveys. *Journal of Research Practice*, *11*(1), 1.
Rovio Entertainment. (2009). *Angry Birds*. Chillingo.
Rozin, P., Scott, S., Dingley, M., Urbanek, J. K., Jiang, H., & Kaltenbach, M. (2011). Nudge to nobesity I: Minor changes in accessibility decrease food intake. *Judgment and Decision Making*, *6*(4), 323.
Russell, P. A. (1973). Relationships between exploratory behaviour and fear: a review. *British Journal of Psychology* , *64*(3), 417–433.
Ryan, R., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1),

68–78.
Ryan, R., & Deci, E. L. (2017). *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Publications.
Ryan, R., Rigby, S., & Przybylski, A. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion*, *30*(4), 344–360.
Salen, K., Tekinbaş, K. S., & Zimmerman, E. (2004). *Rules of Play: Game Design Fundamentals*. MIT Press.
Salen, K., & Zimmerman, E. (2004). Rules of Play: Game design fundamentals. *Cambridge: The MITPress*.
Sam Barlow. (2015). *Her Story*. Sam Barlow.
Sansone, C., & Smith, J. L. (2000). Chapter 12 - Interest and self-regulation: The relation between having to and wanting to. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and Extrinsic Motivation* (pp. 341–372). Academic Press.
Saunders, K., & Novak, J. (2012). *Game Development Essentials: Game Interface Design*. Cengage Learning.
Schattschneider, D. (1990). *Visions of symmetry: Notebooks, periodic drawings, and related work of MC Escher*. WH Freeman New York.
Schell, J. (2014). *The Art of Game Design: A book of lenses*. AK Peters/CRC Press.
Scheurle, J. (2018). *Good Game Design is like a Magic Trick*. GDC Vault. https://www.gdcvault.com/play/1024959/Good-Game-Design-is-like
Schiefele, U. (1999). Interest and Learning From Text. *Scientific Studies of Reading: The Official Journal of the Society for the Scientific Study of Reading*, *3*(3), 257–279.
Schlottmann, A., & Shanks, D. R. (1992). Evidence for a distinction between judged and perceived causality. *The Quarterly Journal of Experimental Psychology. A, Human Experimental Psychology*, *44*(2), 321–342.
Schmidt, L. K. (2016). *Understanding Hermeneutics*. Routledge.
Schmitt, F. F., & Lahroodi, R. (2008). The epistemic value of curiosity. *Educational Theory*, *58*(2), 125–148.
Schoenau-Fog, H. (2011). The Player Engagement Process-An Exploration of Continuation Desire in Digital Games. *DiGRA Conference*. http://www.digra.org/wp-content/uploads/digital-library/11307.06025.pdf
Scholl, B. J., & Tremoulet, P. D. (2000). Perceptual causality and animacy. *Trends in Cognitive Sciences*, *4*(8), 299–309.
Schott, G. (2006). Agency in and around play. *Computer Games: Text, Narrative and Play*, 133–148.
Schreiber, I. (2009, June 29). *Game Design Concepts*. https://learn.canvas.net/courses/3/pages/level-4-dot-4-feedback-loops?module_item_id=44541
Schuemie, M. J., Van Der Straaten, P., Krijn, M., & van der Mast, C. A. (2001). Research on presence in virtual reality: A Survey. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *4*(2), 183–201.
Schutte, N. S., & Malouff, J. M. (2019). Increasing curiosity through autonomy of choice. *Motivation and Emotion*, *43*(4), 563–570.
Scoates, C. (2013). *Brian Eno: Visual Music*. Chronicle Books.
Shafto, M., & MacKay, D. G. (2000). The Moses, mega-Moses, and Armstrong illusions: integrating language comprehension and semantic memory. *Psychological Science*, *11*(5), 372–378.
Shalom, D. E., de Sousa Serro, M. G., Giaconia, M., Martinez, L. M., Rieznik, A., & Sigman, M. (2013). Choosing in freedom or forced to choose? Introspective blindness to psychological forcing in stage-magic. *PloS One*, *8*(3), e58254.
Shaw, J. I., Bergen, J. E., Brown, C. A., & Gallagher, M. E. (2000). Centrality preferences in

choices among similar options. *The Journal of General Psychology*, *127*(2), 157–164.
Sherry, J. L., Lucas, K., Greenberg, B. S., & Lachlan, K. (2006). Video game uses and gratifications as predictors of use and game preference. *Playing Video Games: Motives, Responses, and Consequences*, *24*(1), 213–224.
Shin, D. D., & Kim, S. I. (2019). Homo Curious: Curious or Interested? *Educational Psychology Review*, *31*(4), 853–874.
Shirodkar, T. (2020). *QYJO: Independent Game Developer*. QYJO. http://www.qyjo.in
Shneiderman, B. (2016). *The New ABCs of Research: Achieving Breakthrough Collaborations*. Oxford University Press.
Short, E. (2016, April 12). *Beyond Branching: Quality-Based, Salience-Based, and Waypoint Narrative Structures*. Emily Short's Interactive Storytelling. https://emshort.blog/2016/04/12/beyond-branching-quality-based-and-salience-based-narrative-structures/
Short, E. (2019, November 29). *Storylets: You Want Them*. Emily Short's Interactive Storytelling. https://emshort.blog/2019/11/29/storylets-you-want-them/
Sicart, M. (2015). Loops and Metagames: Understanding Game Design Structures. *FDG*. http://www.fdg2015.org/papers/fdg2015_paper_22.pdf
Silvia, P. J. (2005). What is interesting? Exploring the appraisal structure of interest. *Emotion* , *5*(1), 89–102.
Silvia, P. J. (2006). *Exploring the psychology of interest*. https://books.google.ca/books?hl=en&lr=&id=YxhnDAAAQBAJ&oi=fnd&pg=PA1&ots=NM41QmVTVT&sig=p8grYj4Hi7oIm3ZSEgXUQ2MlvIs
Silvia, P. J. (2012). Curiosity and motivation. *The Oxford Handbook of Human Motivation*, 157–166.
Sivak, S. (2012, September 11). *GAME 3400 Level Design - Moment Based Design*. https://www.slideshare.net/sjsivak/game-3400-level-design-moment-based-design
Song, H., & Schwarz, N. (2008). Fluency and the Detection of Misleading Questions: Low Processing Fluency Attenuates the Moses Illusion. *Social Cognition*, *26*(6), 791–799.
Staewen, R., Trevino, P., & Yun, C. (2014). Player characteristics and their relationship to goals and rewards in video games. *2014 IEEE Games Media Entertainment*, 1–8.
Stemm, R. (2016, April 20). *Video Games as an Art Form*. HowlRound Theatre Commons. https://howlround.com/video-games-art-form
Stolterman, E. (2008). The nature of design practice and implications for interaction design research. *International Journal of Design*, *2*(1). http://ijdesign.org/index.php/IJDesign/article/view/240
Stout, M. (2015, September 24). *Learning from other Media*. Chaotic Stupid. http://www.chaoticstupid.com/learning-from-other-media/
Stout, R. (2010). *Fer-de-Lance*. Random House Publishing Group.
Stuart, K. (2016, November 17). Five lessons that video games could learn from television drama. *The Guardian*. http://www.theguardian.com/technology/2016/nov/17/five-lessons-that-video-games-could-learn-from-television-drama
Studios, H. (2010). *Fruit Ninja*. Halfbrick Studios.
Studios, H. (2011). *Jetpack Joyride*. Halfbrick Studios.
Studio, S. H. (2018). *Blaze Hopper*. Smash Head Studio.
Studios, I. (2011). *Temple Run*. Imangi Studios.
Studio, S. M. G. (2017). *RISK: Global Domination*. SMG Studio.
Subbotsky, E. (2010a). *Magic and the Mind: Mechanisms, Functions, and Development of Magical Thinking and Behavior*. Oxford University Press.

Subbotsky, E. (2010b). Curiosity and exploratory behaviour towards possible and impossible events in children and adults. *British Journal of Psychology* , *101*(Pt 3), 481–501.
Subbotsky, E. (2011). The ghost in the machine: Why and how the belief in magic survives in the rational mind. *Human Development*, *54*(3), 126–143.
Suckley, M. (2017, January 17). *Why PlayRaven is ditching second-to-second gameplay in favour of rich metagame*. Pocketgamer.biz. http://www.pocketgamer.biz/news/64873/why-playraven-favours-metagame/
Suits, B. (1978). *The grasshopper: Games, life and utopia*. University of Toronto Press.
Sundell, T., & Profile, V. my C. (2016, March 30). *Second to Second Gameplay*. Game Development Blog. http://indiedevjourney.blogspot.com/2016/03/second-to-second-gameplay.html
Supercell. (2016). *Clash Royale*. Supercell.
Sutton-Smith, B. (2009). *The Ambiguity of Play*. Harvard University Press.
Swann, W. B., Stephenson, B., & Pittman, T. S. (1981). Curiosity and control: On the determinants of the search for social knowledge. *Journal of Personality and Social Psychology*, *40*(4), 635–642.
Swink, S. (2007a, November 23). *Gamasutra - Game Feel: The Secret Ingredient*. Gamasutra. http://www.gamasutra.com/view/feature/2322/game_feel_the_secret_ingredient.php?print=1%3C/FONT%3E%3C/A%3E%3C/PRE%3E%3CPRE
Swink, S. (2007b, November 23). *Game Feel: The Secret Ingredient*. https://www.gamasutra.com/view/feature/130734/game_feel_the_secret_ingredient.php
Swink, S. (2009). *Game Feel: A Game Designer's Guide to Virtual Sensation*.
Team17. (1995). *Worms*. Ocean Software.
Team Bondi. (2011). *L.A. Noire*. Rockstar Games.
Teller. (n.d.). *Teller - IMDb*. IMDb. Retrieved July 21, 2020, from https://m.imdb.com/name/nm0854418/quotes
Teller, P. (2019). *Penn & Teller Teach the Art of Magic*. MasterClass. https://www.masterclass.com/classes/penn-and-teller-teach-the-art-of-magic
Telltale Games. (2012). *The Walking Dead*. Telltale Games.
Thatgamecompany. (2012). *Journey*. Sony Computer Entertainment.
Thomas, C., Didierjean, A., & Kuhn, G. (2018). It is magic! How impossible solutions prevent the discovery of obvious ones? *The Quarterly Journal of Experimental Psychology*, 2481–2487.
Thomas, C., Didierjean, A., Maquestiaux, F., & Gygax, P. (2015). Does Magic Offer a Cryptozoology Ground for Psychology? *Review of General Psychology: Journal of Division 1, of the American Psychological Association*, *19*(2), 117–128.
Thompson, S. C., Armstrong, W., & Thomas, C. (1998). Illusions of control, underestimations, and accuracy: a control heuristic explanation. *Psychological Bulletin*, *123*(2), 143–161.
Thue, D., Bulitko, V., Spetch, M., & Romanuik, T. (2011). A computational model of perceived agency in video games. *Seventh Artificial Intelligence and Interactive Digital Entertainment Conference*. https://www.aaai.org/ocs/index.php/AIIDE/AIIDE11/paper/viewPaper/4083
Thue, D., Bulitko, V., Spetch, M., & Romanuik, T. (2010). Player Agency and the Relevance of Decisions. *Interactive Storytelling*, 210–215.
Tichon, J. G., & Tornqvist, D. (2016). Video Games: Developing Resilience, Competence, and Mastery. In *Integrating Technology in Positive Psychology Practice* (pp. 247–265). IGI Global.

To, A., Safinah, A., Kaufman, G. F., & Hammer, J. (2016). Integrating Curiosity and Uncertainty in Game Design. *DiGRA/FDG*. http://www.digra.org/wp-content/uploads/digital-library/paper_428.pdf

Tobias-Webb, J., Limbrick-Oldfield, E. H., Gillan, C. M., Moore, J. W., Aitken, M. R. F., & Clark, L. (2017). Let me take the wheel: Illusory control and sense of agency. *Quarterly Journal of Experimental Psychology* , *70*(8), 1732–1746.

Tognazzini, B. (1993). Principles, Techniques, and Ethics of Stage Magic and Their Application to Human Interface Design. *Proceedings of the INTERACT '93 and CHI '93 Conference on Human Factors in Computing Systems*, 355–362.

Trefry, G. (2010). *Casual game design: designing play for the gamer in all of us*. CRC Press.

Triplett, N. (1900). The Psychology of Conjuring Deceptions. *The American Journal of Psychology*, *11*(4), 439–510.

Truffaut, F., Hitchcock, A., & Scott, H. G. (1984). *Hitchcock*. Simon and Schuster.

Tseng, F.-C. (2011). Segmenting online gamers by motivation. *Expert Systems with Applications*, *38*(6), 7693–7697.

Tuunanen, J., & Hamari, J. (2012). Meta-synthesis of player typologies. *Proceedings of Nordic Digra 2012 Conference: Games in Culture and Society, Tampere, Finland*. http://www.digra.org/wp-content/uploads/digital-library/12168.40312.pdf

Tyack, A., & Mekler, E. D. (2020). Self-Determination Theory in HCI Games Research: Current Uses and Open Questions. *Proceedings of the 2020 CHI Conference on*. https://dl.acm.org/doi/abs/10.1145/3313831.3376723?casa_token=CxLexbUGX8kAAAAA:MjbrAz7kfRJ-kw3W5b-hUnejj-O9BwRPxjHaeWgQrvycDIpUCzCtivSZ82A27puxwWmPpWz6DkmL

Ubisoft. (1995). *Rayman*. Feral Interactive.

Ustwo Games. (2014). *Monument Valley*. Ustwo Games.

Valve. (2000). *Counter-Strike*. Valve.

Valve Corporation. (2007). *Portal*. Valve Corporation.

VandenBerghe, J. (2012). *The 5 Domains of Play: Applying Psychology's Big 5 Motivation Domains to Games*. GDC Vault. https://www.gdcvault.com/play/1015364/The-5-Domains-of-Play

VandenBerghe, J. (2016). *Engines of Play: How Player Motivation Changes Over Time*. GDCVault. https://www.gdcvault.com/play/1023329/Engines-of-Play-How-Player

van Lieshout, L. L. F., Vandenbroucke, A. R. E., Müller, N. C. J., Cools, R., & de Lange, F. P. (2018). Induction and Relief of Curiosity Elicit Parietal and Frontal Activity. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, *38*(10), 2579–2588.

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, *44*(1), 1–31.

Vidler, D. C., & Levine, J. (1981). Curiosity, Magic, and the Teacher. *Education*, *101*(3), 273.

Vilaza, G. N., Haselager, W. F. F., Campos, A. M. C., & Vuurpijl, L. (2014). Using games to investigate sense of agency and attribution of responsibility. *Proceedings of the 2014 SBGames (SBgames 2014), SBC, Porte Alegre*. http://www.sbgames.org/sbgames2014/app/webroot/files/papers/culture/full/Cult_Full_Using%20games%20to%20investigate.pdf

Vlaada Chvátil. (2015). *Codenames*. Czech Games.

Wardrip-Fruin, N., Mateas, M., Dow, S., & Sali, S. (2009). Agency Reconsidered. *DiGRA Conference*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.190.1393&rep=rep1&t

ype=pdf
Wegner, D. M. (2003). The mind's best trick: how we experience conscious will. *Trends in Cognitive Sciences*, *7*(2), 65–69.
Weiner, B. (2013). *Human Motivation*. Psychology Press.
Weiss, G. H. (1979). *The Theory of Gambling and Statistical Logic (Richard A. Epstein)*. Society for Industrial and Applied Mathematics. https://doi.org/10.1137/1021045
Weyhrauch, P., & Bates, J. (1997). *Guiding interactive drama*. Carnegie Mellon University Pittsburgh, PA.
Whang, L. S.-M., & Chang, G. (2004). Lifestyles of virtual world residents: Living in the on-line game" Lineage." *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *7*(5), 592–600.
White, M. M. (2014). *Learn to Play: Designing Tutorials for Video Games*. CRC Press.
White, R. W. (1959). Motivation reconsidered: the concept of competence. *Psychological Review*, *66*, 297–333.
WhiteWolf. (1991). *Vampire: The Masquerade*. White Wolf Publishing.
Williams, H., & McOwan, P. W. (2014). Magic in the machine: a computational magician's assistant. *Frontiers in Psychology*, *5*, 1283.
Wilson, T. D., Centerbar, D. B., Kermer, D. A., & Gilbert, D. T. (2005). The pleasures of uncertainty: prolonging positive moods in ways people do not anticipate. *Journal of Personality and Social Psychology*, *88*(1), 5–21.
Winn, B., & Heeter, C. (2006). Resolving conflicts in educational game design through playtesting. *Innovate: Journal of Online Education*, *3*(2). https://www.learntechlib.org/p/104284/
Wright, W. (2001). *Will Wright's Design Plunder*. GDC. https://www.youtube.com/watch?v=_Um5hfcXchU
Yang, K. S. (2003). Beyond Maslow's culture-bound linear theory: a preliminary statement of the double-Y model of basic human needs. *Nebraska Symposium on Motivation. Nebraska Symposium on Motivation*, *49*, 175–255.
Yee, N. (2006). Motivations for play in online games. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *9*(6), 772–775.
Yee, N. (2019a). *A Deep Dive into the 12 Motivations: Findings from 400,000+ Gamers*. GDC Vault. https://www.gdcvault.com/play/1025742/A-Deep-Dive-into-the
Yee, N. (2019b). *Quantic Foundry*. Quantic Foundry. https://quanticfoundry.com/
Yee, N. (2016). The Gamer Motivation Profile: What We Learned From 250,000 Gamers. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 2–2.
Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 493–502.
Zukowski, C. (2018, January 23). *What we can learn from indie fiction authors*. Gamasutra. https://www.gamasutra.com/blogs/ChrisZukowski/20180123/313397/What_we_can_learn_from_indie_fiction_authors.php
Zusne, L., & Jones, W. H. (2014). *Anomalistic Psychology: A Study of Magical Thinking*. Psychology Press.