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Perceptions, motivations, decisions: What initiates harmful gambling?

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About this report

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About the Bristol Hub for Gambling Harms Research

Established in 2022, our purpose is to build interdisciplinary capacity in gambling harms research nationally and globally, in order to prevent and reduce harms at individual, community and society level. For more information visit www.bristol.ac.uk/gambling-harms.

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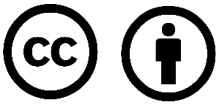

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Executive Summary

The work of the Bristol Hub for Gambling Harms Research is framed around four challenges:

These four Challenges broadly represent a 'gambling pathway' and are designed to create space for interdisciplinary approaches to the different dimensions of harmful gambling, namely: what initiates harmful gambling; what is the everyday practice and portrayal of gambling in social groups; what social and spatial inequalities exacerbate gambling harms; and what socio-technical innovations can help prevent or reduce gambling harms.

To inform the work of the Hub, we conducted four scoping reviews, each of which addresses one of the Challenges set out above. Our scoping reviews followed the process outlined by Arksey and O'Malley (2005). They were pre-registered on Open Science Framework and conducted according to PRISMA guidelines.

This report sets out the evidence from the scoping review for Challenge 1: What initiates harmful gambling?

It explores the inter-individual factors that may make some people more susceptible to gambling harms than others. Specifically, it considers the evidence on how biological, psychological, cognitive and environmental

factors may act separately and in conjunction with each other to initiate harmful gambling.

Given both the wealth of research already published on the relationship between these factors and harmful gambling, and the timeframe of the scoping review (from 2005 onwards), we only included papers that were reviews of previous studies. These comprised systematic reviews, meta-analyses of pre-existing data, and selective reviews. The evidence presented in this scoping review report is drawn from 87 review papers and covers three main topics:

1. The biological factors that can increase the risk of harmful gambling;
2. The psychological and cognitive factors that can increase the risk of harmful gambling;
3. How biological, psychological, and cognitive factors can interact with ecological or environmental factors to increase the risk of harmful gambling.

As most of the studies contained in the review papers have not tracked people over time, they can only show that there is some association between these factors and harmful gambling; they have not been able to establish cause-and-effect relationships.

Biological factors

- The biological factors that may result in some individuals being at higher risk of gambling harms than others relate to their genes and their neurophysiology (i.e. how the brain and nervous system function).
- Genetic factors – predominantly explored in studies of twins - play an important role in mediating the motivations or perceptions related to gambling. In particular, a range of studies highlight the influence of dopamine-related genes (which are linked to reward pathways in the brain) and serotonin-related genes (which are linked to behavioural regulation) in shaping people's gambling-related motivations and perceptions.
- Neuroscientific studies (which focus on the brain and nervous system) have found that different areas of the brain work together in the case of harmful gambling, which in turn can be associated with increased reward-seeking, reduced cognitive control, and increased dopamine release.
- Research has also explored the prevalence of harmful gambling alongside other conditions. Harmful gambling has been found to be associated with treatment for Parkinson's disease, while studies have also shown an association between harmful gambling and attention deficit hyperactivity disorder (ADHD, a condition that affects people's behaviour); obsessive compulsive disorder (OCD, a mental health condition where a person has obsessive thoughts and compulsive behaviours); and childhood maltreatment and later harmful gambling.

Psychological and cognitive factors

- The onset of harmful gambling behaviours has been associated with a wide range of psychological, cognitive, and other individual factors. All of these can play a role in people's perceptions, motivations and decision-making around gambling.
- Alexithymia (the inability to accurately describe, conceptualise, and feel emotions) has been shown to be associated with increased risk of harmful gambling.
- Separately, those who are experiencing harmful gambling are more likely to feel greater arousal from gambling-related stimuli, such as gambling-related marketing. Harmful gambling has also been associated with specific personality traits, such as neuroticism (associated with negative emotions).
- Research has also shown that cognitive factors can affect the decision-making processes of people at risk of harmful gambling. For example, stress can contribute to – and be caused by – harmful gambling. In addition, studies show links between harmful gambling and high impulsivity, low inhibition, reduced perceptions of risk, and cognitive distortions (irrational thoughts that can influence our emotions).
- Wider individual differences - notably age and financial motivations - can affect people's perceptions, motivations or decision-making processes in relation to harmful gambling. Financial motives have been found to be positively associated with both frequency and level of 'problem gambling'. The evidence shows that young people perceive gambling as normal and increasingly accessible.

The interaction between individual-level factors and environmental factors

- Our scoping review highlights a growing body of evidence on how individual-level factors interact with environmental cues (features or elements in someone's environment that consciously or unconsciously provide information, feedback, guidance or motivation).
- This evidence presents an important evolution from theoretical pathway models that subtype harmful gambling *after* individuals have already experienced harm, by exploring how individual-level factors interact with environmental cues to lead to the initiation of harmful gambling.
- An important example of this interaction is the availability of gambling, which has been shown to heighten the risk of harmful gambling, with studies that have explored this in relation to different types of gambling products.
- Similarly, the interaction between psychological, cognitive and environmental cues can also lead to heightened risk of harmful gambling, through the availability of simulated gambling products. These are online gambling-like activities, such as social casino games

and video games with gambling content, which do not involve the exchange of money, although some games allow players to purchase virtual credits. Simulated gambling can alter gambling-related cognitions in young people, while engagement with virtual communities can normalise gambling. In addition, electronic gaming machine (EGM)-based products are associated with dissociation (detachment from reality), while increased exposure to gambling-related marketing can result in higher recall and intent to gamble.

1 Introduction

1.1 Background

The work of the Bristol Hub for Gambling Harms Research is framed around four challenges:

These four Challenges broadly represent a 'gambling pathway' and are designed to create space for interdisciplinary approaches to the different dimensions of harmful gambling, namely: what initiates harmful gambling; what is the everyday practice and portrayal of gambling in social groups; what social and spatial inequalities exacerbate gambling harms; and what socio-technical innovations can help prevent or reduce gambling harms.

To inform the work of the Hub, we conducted four scoping reviews, each of which addresses one of the Challenges set out above. Scoping reviews aim to address wide-ranging topics where different study designs might be applicable (e.g. qualitative studies, quantitative surveys, laboratory experiments). As a result, they tend to be guided by broader research questions and do not assess the quality of included studies (Arksey and O'Malley, 2005).

This report sets out the evidence from the scoping review for Challenge 1: What initiates harmful gambling? The purpose of this scoping review is, firstly, to examine the extent, range and nature of research activity on this topic; and secondly to describe the findings of the research we identified for dissemination to academic and non-academic audiences (Arksey and O'Malley, 2005).

1.2 What is perception, motivation and decision-making in the context of initiating gambling?

Perception, motivation and decision-making can all impact the initiation of gambling behaviours. Firstly, perceptions can reflect not only our own understanding of behaviours or how they are understood by others, but how such understanding can be impacted by environmental factors. We therefore define perceptions in relation to gambling as including self-perception (how people perceive *themselves*), external perceptions (how *others* perceive – and behave towards – those at risk of harm), and how perceptions are impacted by environmental factors (such as responsible gambling messages or commercial determinants such as the presence of marketing).

Motivation, in simple terms, could be defined as a reason – or reasons – for behaving in a certain way. However, motivated behaviours that depend on internal factors can be difficult to characterise as they are related to an individual's own cognition (Gottlieb et al., 2016). Additionally, motivation can be intrinsic or extrinsic in nature. Intrinsic motivation is the carrying out of an activity for enjoyment or satisfaction, rather than for a tangible consequence. In other words, "When intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards" (Ryan and Deci, 2000, p. 56). Extrinsic motivation, on the other hand, is the carrying out of an activity for external reasons (Ryan and Deci, 2000). For example, a student who completes homework "because she believes it is valuable for her chosen career is […] extrinsically motivated because she too is doing it for its instrumental value" (Ryan and Deci, 2000, p. 60). Therefore, motivation in the context of initiating gambling can consist of the enjoyment of gambling itself, or the desire to gain other outcomes such as financial gain.

Decision-making, meanwhile, is the "mental processing that leads to the selection of one among several actions (choices)" (Newell and Shanks, 2014, p. 2). Decision-making is therefore a process that relies on perceptions and motivations of the individual. Additionally, Newell and Shanks (2014) highlight how cues presented by the environment can also influence the decision maker in their selection of choices. Cues presented by the environment – unknown to the individual - may also exert an unconscious influence on decisions. Therefore, decision-making in relation to gambling highlights how internal perceptions, motivations (including internal and external) interact with certain cues to lead to gambling behaviours.

Many of the aspects mentioned above, particularly in relation to environmental factors (for example, availability of gambling, responsible gambling messaging, gambling as a social activity) are explored within the reports from the scoping reviews for Challenges Two, Three, and Four (Ford et al., 2024; Wheaton et al., 2024a, 2024b). This review explores the inter-individual factors that may make someone more susceptible to the gambling harms over

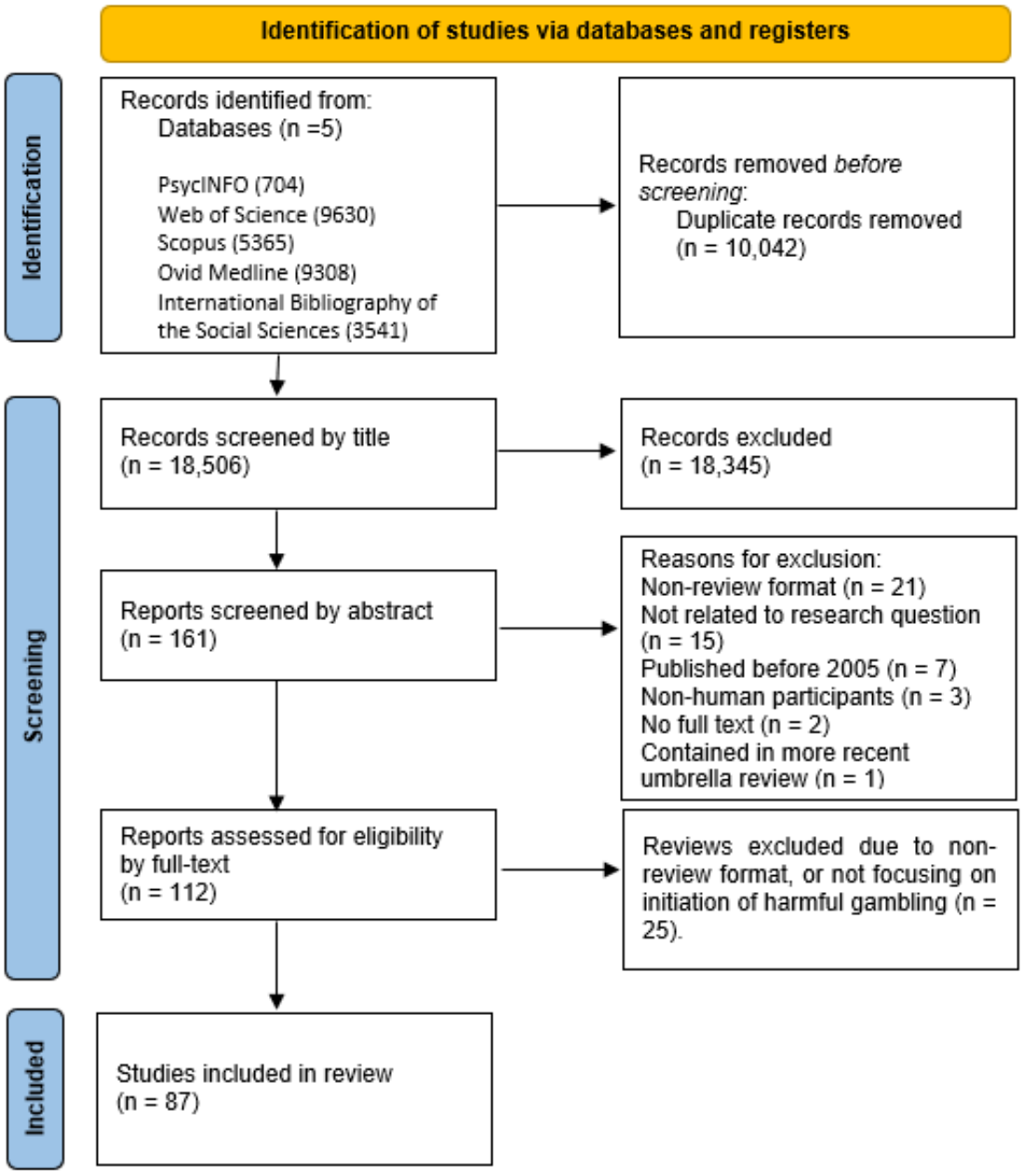
others by exploring how biological, psychological, and environmental factors act individually – as well as interact – to initiate harmful gambling.

1.3 Research methods

Our scoping review followed the process outlined by Arksey and O'Malley (2005). It was pre-registered on Open Science Framework (https://doi.org/10.17605/OSF.IO/REW23) and conducted according to PRISMA guidelines (Page et al., 2021). Guided by the research question, 'What initiates harmful gambling?', we used key search terms – related to gambling, motivation, perception and decision-making - to identify relevant studies from multiple academic databases: Web of Science, PsycINFO, Scopus, Ovid Medline and the International Bibliography of the Social Sciences. Full details of the search terms can be found in **Appendix One.**

Given the wealth of research already published in relation to individual factors and harmful gambling, and the timeframe of the scoping review, we decided to focus on papers that were reviews of previous studies. This included systematic reviews, meta-analyses of pre-existing data, or selective reviews. To be included, reviews needed to be published in English, focused on the economies of OECD member countries, published in or after 2005 (the year when the Gambling Act 2005 was passed), and be specifically linked to the research question. The process of the literature review is shown in Figure 1. The initial search – after de-duplication – returned 18,506 reviews which were then sifted according to title. Titles were required to demonstrate a clear focus on the initiation of harmful gambling. The first sift, which saw titles compared to the inclusion criteria above, reduced the sample to 313 reviews. The second sift by abstract then reduced the working sample to 112 reviews. The 112 reviews identified were screened by full-text, resulting in 87 retained for data extraction. Details of excluded papers and the reasons for exclusion can be accessed through the OSF link. See Figure 1 for the PRISMA flow-chart. More details on the number of included reviews and the number of excluded reviews at each stage of the scoping review can be found in **Appendix Two**.

Figure 1: PRISMA flow diagram for Challenge 1 Scoping Review



Data were abstracted from the sample of 87 reviews according to specific variables: topic; aim; population studied; country; methodology; number of studies included; outcome variables; funding source(s)/declarations of interest; summary/key points; and limitations. These terms are fully defined in **Appendix Two**. The summary of findings abstracted from each review within the sample were then analysed to develop the main themes which answer the guiding research question.

1.4 This report

This report reviews the findings from our scoping review of systematic reviews. The main findings are outlined in three chapters which explore the

factors that may result in some individuals being at a higher risk of initiating harmful gambling than others. Specifically, the chapters report themes in relation to:

1. The biological factors that can increase the risk of harmful gambling;
2. The psychological and cognitive factors that can increase the risk of harmful gambling;
3. How biological, psychological, and cognitive factors can interact with ecological or environmental factors to increase the risk of harmful gambling.

1.4.1 A note on terms used in the report

Gambling harms are the short and long-term adverse impacts from gambling on the health and wellbeing of individuals, families, communities, and society. These harms are diverse but three commonly referenced categories are resource harms, relationship harms, and health harms (Wardle et al., 2018).

However, much of the extant literature focuses on the narrower concepts of 'problem gamblers/gambling' and 'pathological gamblers/gambling' which are defined in Table 1. These terms refer only to the person who gambles and are measured using standard screening tools, for example to estimate prevalence rates or for analytical or descriptive purposes.

We use the terms 'problem gamblers/gambling' and 'pathological gamblers/gambling' in this report in the same way as they are reported in the original studies, while acknowledging concerns that these terms are stigmatising, and that their use in measuring prevalence underestimates the harms caused by gambling. We use 'harmful gambling' as a default term to refer to gambling behaviours that may harm the individual and others, as this offers an alternative term that seeks to reduce stigma.

Table 1: Definitions of 'Pathological' and 'Problem Gambling'

Pathological Gambling	Persistent and maladaptive gambling behaviour that disrupts personal, family, or vocational pursuits (American Psychiatric Association, 2000, p. 671).
Problem Gambling	Gambling behaviour that creates negative consequences for the gambler, others in his or her social network, or for the community (Ferris and Wynne, 2001, p. 8).

In addition, Table 2 sets out all the different measures that are mentioned in this report and the screening tools from which they derive, along with the original reviews that first described them. The descriptions within each table also highlight how they are intended to be used in relation to their outcome measure. For example, some of the surveys intend to measure the prevalence of problem gambling in the general population, whilst others may measure pathological gambling, or urges to gamble in an individual.

Table 2: Glossary of gambling screening tools

Screening tool	Description	Outcome Measure
Addiction Severity Index amended for Gambling (ASI-G) (Lesieur and Blume, 1982).	A screening tool derived from the Addiction Severity Index, normally deployed to measure drug and substance addiction, developed to measure pathological gambling.	Pathological Gambling
Canadian Adolescent Gambling Inventory (CAGI) (Wiebe et al., 2007).	A 26-item screening tool comprising measurements of types of gambling activities, frequency of participation, time spent gambling, total money spent on gambling, and psychological, social, financial aspects related to gambling risk or harm.	Pathological Gambling
Canadian Problem Gambling Index (CPGI) (Ferris and Wynne, 2001).	A 31-item screening tool to determine whether a person in the general population is experiencing problem gambling.	Problem Gambling
Fourth edition of the Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-IV) (American Psychiatric Association, 2000).	Ten criteria created by clinicians for diagnosis of pathological gambling.	Pathological Gambling
Gambling Abstinence Self-Efficacy Scale (GASS) (Hodgins et al., 2004)	A 21-item measure of gambling abstinence self-efficacy.	Gambling Abstinence
Gambling Symptom Assessment Scale (G-SAS) (Kim et al., 2009).	A 12-item self-rated scale designed to assess gambling symptom severity.	Gambling Symptom Severity
Gambling Related Cognition Scale (GRCS) (Raylu and Oei, 2004a).	A 23-item scale designed to assess gambling-related cognitions held by gambling. Aspects explored by the scale include interpretive control/bias, illusion of control, predictive control, gambling-related expectancies, perceived inability to stop gambling.	Gambling-related Cognitions.
Gambling Urge Scale (GUS) (Raylu and Oei, 2004b).	A six-item self-screening tool designed to measure gambling urges.	Gambling Urges

Table 2, cont.: Glossary of gambling screening tools

Screening tool	Description	Outcome Measure
Game Experience Questionnaire (GEQ) (IJsselsteijn et al., 2013).	A modular questionnaire that measures the multifaceted experience of gaming. The questionnaire has three modules: core, social presence, post-game	Flow, competence, positive and negative affect, tension, and challenge (core).
National Opinion Research Center DSM Screen for Gambling Problems (NODS) (Wickwire et al., 2008).	A 34-item telephone-screening tool that identifies gambling problems as defined by the DSM-IV.	Problem and Pathological Gambling
Problem Gambling Severity Index (PGSI) (Ferris and Wynne, 2001).	A nine-item measure constructed specifically to measure problem gambling in the general population.	Problem Gambling
Short Gambling Harm Screen (SGHS) (Browne et al., 2018).	A short, 10-item screening tool to measure gambling harms.	Gambling Harms
South Oaks Gambling Screen (SOGS). (Stinchfield, 2002).	A 20-item questionnaire based on DSM-III criteria.	Pathological Gambling
Victorian Gambling Screen Harm to Self-Scale (VGS-HS). (Ben-Tovim et al., 2001).	A 15-item screening tool designed to measure the harm occurring to self as a result of gambling	Harm as a result of Problem Gambling

2 Biological factors

Chapter Summary

- This chapter reviews the biological factors that may result in individuals being at higher risk of gambling harms compared to others. This includes genetic and neurophysiological factors, while neuroscientific studies were also uncovered.
- The evidence base was formed of 27 reviews, most of which reviewed extant quantitative studies. The evidence was also mainly formed of cross-sectional data, and causation is thus difficult to prove.
- Genetic factors can play an important role in mediating the motivations or perceptions related to gambling. In particular, a range of studies highlight the influence of dopamine-related genes (which are linked to reward pathways in the brain) and serotonin-related genes (which are linked to behavioural regulation) in shaping people's gambling-related motivations and perceptions.
- Studies in the field of neuroscience (which focus on the brain and nervous system) have found that different areas of the brain work together in the case of harmful gambling, which in turn can be associated with increased reward-seeking, reduced cognitive control, and increased dopamine release.
- Research has also explored the prevalence of harmful gambling alongside a range of neuropsychological conditions. Harmful gambling has been found to be associated with treatment for Parkinson's disease, while there is also an association between ADHD and harmful gambling, OCD and harmful gambling, and childhood maltreatment and later harmful gambling.

2.1 Introduction

This chapter reviews the evidence that biological factors can impact the perceptions, motivations and decision-making processes that lead to the initiation of harmful gambling. Our scoping review found that genetic factors were an important predictor of what initiates harmful gambling behaviour, although it is not clear what predispositions and environmental interactions moderate the relationship between genetic factors and harmful gambling. We also found research on the neurophysiological underpinnings of gambling behaviour, with the focus being on attention, reward processing, learning and memory, and executive functions (for example, inhibition, planning, and decision making), and research that explores how neuropsychological conditions (and their treatment) may impact gambling-related cognitions.

We begin by outlining the evidence base of systematic reviews and meta-analyses that inform the findings in this chapter. Secondly, we review the research around the genetic factors that may influence gambling behaviour, before exploring the neuroscientific factors uncovered from our scoping review. Finally, we review the neuropsychological conditions that may co-exist alongside genetic factors and therefore put some individuals at higher risk of harmful gambling than others.

2.2 About the evidence base

The evidence base that generated the themes in this chapter was formed of 27 reviews, almost all of which reviewed individual quantitative studies. Dowling et al.'s (2015) review and meta-analysis of the prevalence of co-morbid psychiatric disorders amongst treatment-seeking 'problem gamblers' was an exception to this rule, reviewing 36 qualitative and 15 quantitative studies. The sample sizes of reviews covered in this chapter ranged from four individual studies (Moccia et al., 2017) to 179 studies (Clark et al., 2019). There was also a wide range of populations studied within the sample, consisting of different age groups, as well as participants experiencing different levels of risky gambling behaviours. While we have reported the jurisdictions of the studies in the three other scoping review reports (Ford et al., 2024; Wheaton et al., 2024a, 2024b), the studies explored in this scoping review did not always report their findings by jurisdiction. We also note that some of the findings in the scoping review were only reported by a single review paper. For example, the association between obsessive-compulsive disorder and harmful gambling was only explored by Durdle et al. (2008), while Richard et al.'s (2020) review was the only one that explored the role of conduct problems as a risk factor for harmful gambling.

2.3 Genetic factors play an important role in gambling-related outcomes

Our review found that genetic factors play an important role in gambling-related outcomes, with results from two systematic reviews agreeing that they explain large proportions of the variance of outcomes using twin-studies. By using twin-studies where identical (100% shared genes) and non-identical (50% shared genes) twins are compared, researchers can understand the relative contributions of genetic and environmental factors to a given outcome. For example, if gambling behaviour is more prevalent amongst identical than non-identical twins, then this provides evidence for genetic influence in the perceptions and motivations that initiate gambling. Additionally, identical twins raised in the same environment will share more environmental factors compared to twins raised apart. In summary, comparing twins can disassociate specific shared and non-shared environmental factors.

Gyollai et al. (2014) conducted a systematic review of the evidence of genetic influences on 'problem' and 'pathological gambling'. Results from twin studies suggested that genetic factors contribute significantly to the formation of harmful gambling, with genetic factors explaining between 32% and 72% of the variance in gambling-related outcomes. This large variance is explained irrespective of the definition of – and screen used to assess - gambling severity. Shared environmental factors did not appear to contribute to gambling-related outcomes, except for females in two studies that found contributions of 42% and 45%. Non-shared environmental effects explained between 15% and 55% of variance. The authors concluded that the data

reviewed demonstrated the genetic vulnerability of ‘problem’ and ‘pathological gambling’, and they recommended that ‘pathological gambling’ should be included as a subtype of Reward Deficiency Syndrome. In this sense, genetic factors therefore impact the motivation to gamble in relation to reward-seeking.

Xuan et al. (2017) also examined twin studies of pathological gambling behaviour - including many that were also reviewed by Gyollai et al. (2014) - and came to similar conclusions. Overall, they reported that genetic influences accounted for around 50% of gambling behaviour, with non-shared environmental influences (such as unique life events or friends who are not shared with siblings) also contributing 50%. They concluded that shared environments (for example, family events or shared friends, school experiences) played a negligible role in the formation of gambling-related outcomes. More specifically, however, they found age and sex to be significant moderators. Genetic influence was greater for male gambling (47%) compared to female gambling (28%). Shared environment had noticeable effects on female gambling, and no impact on male gambling, while the impact of non-shared environment on male gambling (53%) was slightly less than female gambling (58%). As for age, adolescents had less additive genetic influence (42% vs 53%) and more non-shared environmental effects (58% vs 47%). Overall, genetic influence and non-shared environmental factors explained significant and relatively equal proportions of the variance in gambling outcomes. Shared environmental influences were insignificant for males but explained a smaller but significant amount of variance for females.

Gyollai et al. (2014) also reviewed non-twin studies to examine the impact of genes of dopamine receptors, serotonergic systems and individual genetic differences. The authors argued that this finding was not surprising given that these two systems are the most frequently examined systems in relation to addiction. When exploring the initiation of gambling behaviours, dopamine may play a role as a neurotransmitter influencing pleasure, motivation and learning. Serotonin, meanwhile, is most likely to influence impulse control, and mood regulation. In relation to genetic studies on the D2 receptor gene (dopamine), six studies reported a significant association. In terms of single nucleotide polymorphisms (SNPs) from the entire genome, there is some evidence that SNPs on specific genes have a significant association with ‘pathological gambling’. However, other gene polymorphisms showed mixed findings or relationships with comorbidities or impulsive behaviours more generally, which would explain evidence of common comorbidities.

Pettorruso et al. (2020) also examined 19 studies on dopamine-related genes in gambling disorder. All but one study found significant associations between dopamine receptor genes and gambling disorder, with possible pathophysiological action of epigenetic processes. As for dopamine function, there were no results showing any association between D2 receptor availability and gambling disorder. Only in the ‘most severe gamblers’ was D2 dopamine release elevated. The main significant finding was that three studies reported increased dopamine synthesis capacity in the basal ganglia – a group of structures found deep within the brain that are involved in the co-

ordination of movement - in gambling disorder. This supports the idea of gambling disorder as a hyper-dopaminergic disorder.

Overall, genetic factors influence the initiation and maintenance of 'pathological gambling'. In terms of genetic association, dopaminergic and serotonin involvement is not surprising given the similarity to other addiction disorders; dopamine because of the reward pathways and serotonin because of behavioural inhibition. This therefore indicates that genetic factors play an integral role in the motivation and perceptions of gambling. Overall, however, there is still limited understanding of the specific factors influenced by genetic factors that most strongly moderate the relationship to harmful gambling outcomes. There is also no understanding of the relative contribution of genetics and environment that contribute to each 'risk factor' specifically, as these are also likely to vary.

2.4 Neuroscience/Cognitive Neuroscience

We also uncovered reviews that explored the relationship between brain activity and the motivations and perceptions that can lead to harmful gambling behaviours. These reviews found that harmful gambling can be associated with increased reward-seeking, loss of cognitive control, and the heightened release of dopamine. We also found one review that explores how different regions of the brain – relating to reward, learning, and the executive functions – work together. These themes are introduced in turn below.

2.4.1 Harmful gambling is associated with increased reward-seeking

Van Holst et al. (2010) reviewed neuroimaging findings in relation to 'pathological gambling'. They reported that 'pathological gamblers' experienced increased reward-seeking together with lowered reward sensitivity. This was characterized by diminished neural responses to natural rewarding stimuli in brain networks related to motor and reward processing (ventral striatum) and mid-frontal regions (ventromedial prefrontal cortex - vmPFC). In addition to a diminished response to rewards, they also found lower punishment sensitivity, suggesting that those experiencing 'pathological gambling' experienced lower sensitivity to outcomes. In terms of explaining reward-seeking, one potential cognitive mechanism is the enhanced cue reactivity and attentional bias to gambling-related cues found for 'pathological gamblers', although a lack of evidence meant the neurophysiological mechanisms remained unclear. Another crucial finding was that 'pathological gamblers' showed compromised decision-making and impulse control, as well as specific difficulty in filtering out irrelevant information and inhibiting ongoing responses. Overall, this review from over a decade ago demonstrated the broad range of general neurophysiological correlates that have become consistently associated with difficulty with gambling, even if the specific mechanisms remained to be determined.

Further work has since confirmed the results of Van Holst et al. (2010) while adding greater detail. Meng et al. (2014) performed a meta-analysis of functional MRI (fMRI) studies on reward pathway dysfunction in gambling disorder (gambling disorder). FMRI imaging tracks changes in blood flow, revealing which brain regions are active during specific tasks or behaviours. Compared to healthy controls, they found reliable clusters of abnormal activation related to gambling disorder in the right lentiform nucleus (rLN) and left middle occipital gyrus areas of the brain. When controlling for substance-use disorder, the increased activity in right lentiform nucleus remained. Symptom severity was positively related to rLN hyperactivity and negatively related to right middle frontal gyrus (MFG). This indicates the importance of the frontostriatal cortical pathway in the clinical treatment of gambling disorder. This pathway is integral to executive functioning, inhibitory control or the ability to stop gambling, as well as reward, control and motor-circuits.

2.4.2 Harmful gambling can be associated with reduced cognitive control

Taking more of a focus on cognitive control, Moccia et al. (2017) reviewed evidence on neural correlates of executive function. Cognitive control is defined by the authors as the sum of several cognitive processes, all of which play an important role in the emotions, thoughts or behaviours associated with harmful gambling: response inhibition, conflict monitoring, cognitive flexibility, and decision-making. The authors systematically reviewed fMRI studies to investigate the neural mechanisms underlying diminished cognitive control in gambling disorder. Although the evidence was relatively weak and there was significant methodological heterogeneity within the studies they reviewed, they found evidence for impaired activity across many prefrontal areas of the brain (dorsolateral prefrontal cortex (dlPFC), anterior cingulate cortex (ACC), orbitofrontal cortex (OFC), ventromedial prefrontal cortex (vmPFC)) that have been associated with various aspects of cognitive control such as decision-making, response inhibition, reversal learning, coordination of context appropriate behaviours, and cognitive flexibility. However, the specific relationships between these areas and their role in gambling disorder is still unclear. Additionally, the studies they reviewed did not isolate executive functions, and only a few evaluated cognitive control in ecologically valid settings (such as within gambling scenarios or with the use of gambling-related cues).

Similarly, Quaglieri et al. (2020) reviewed – and performed a meta-analysis of studies that explored - neurophysiological correlates of executive function in gambling disorder and alcohol-use disorder. They demonstrated distinct functional activity in gambling disorder, notably different from that seen in alcohol-use disorder, with regard to clusters of abnormal activity in the cingulate nucleus, lenticular nucleus and medial frontal gyrus, as well as hyperactivity in the dorsal ACC. This suggests that the rewards system's afferent and efferent projections – or the rewards system's inputs and outputs that mediate reward-seeking behaviours - are pathologically involved in

compulsive reward-seeking behaviours like gambling. In other words, the input circuits that process information arriving into the reward-seeking system, and output circuits that influence actions and decisions, both influence gambling behaviours. Hyperactivity of the dorsal striatum might be linked to overestimation of gambling outcomes because of the stronger action-outcome associations forged. The frontostriatal cortical circuit (right lenticular nucleus (LN) and MFG) - specifically higher activation of the LN - during executive tasks in gambling disorder are consistent with the idea of dysfunction in the reward circuit, inhibitory control and motor planning. Overall, they suggest that an imbalance between the dopaminergic system responsible for reward-seeking or motivation (including limbic areas responsible for processing emotions or regulating behaviours) and connectivity to frontal regions (and links to basal ganglia – frontostriatal circuits) contribute to impaired and progressive loss of cognitive control over gambling behaviours.

2.4.3 Brain imaging highlights increased dopamine release during harmful gambling

With more focus on reward networks, Clark et al. (2019) reviewed the neuroimaging findings from reward mechanism research in gambling disorder. They focussed on both structural and functional MRI, in addition to positron emission tomography (PET) studies. Whereas fMRI tracks changes in blood flow, revealing which brain regions are active during specific tasks or behaviours, structural MRI captures details of the brain's structural anatomy, like its volume and structural connectivity. PET studies consist of a medical imaging technique that explores the function of organs or tissues inside the body. In the case of Clark et al.'s (2019) study, PET studies focused on neurotransmitter function. Together, they help researchers understand how brain structure relates to function, shedding light on the biological basis of behaviour.

Structural MRI data found inconclusive evidence for grey matter deficits in gambling disorders, especially compared to substance-use disorder, as well as similarities to substance-use disorders in terms of finding consistent reductions in white-matter integrity of a distributed nature. However, they concluded that it is unclear whether grey or white matter alterations relate to reward-based symptoms. They did find more general evidence for structural correlates of poorer impulsivity but noted that this was not specific to gambling disorder and was therefore likely to be reflective of other disorders. On the other hand, fMRI data revealed a consistent finding of dysregulation in core circuits related to reward processing and executive control, encompassing the ventral striatum, mPFC, OFC and affiliated regions like the insula, dlPFC. However, it is important to understand that the type of dysregulation (hypo-activity vs hyper-activity) is mixed, as is seen with substance-use disorders.

Finally, the authors noted that PET studies interested in neurochemical correlates demonstrated no differences between dopamine binding of

participants with a gambling disorder and controls. However, one study found elevated GABA-A – a chemical neurotransmitter associated with the disinhibition of dopamine release - in gambling disorder. Evidence emerged from a few studies for increased dopamine release related to impulsivity and risk choice. This contrasts pointedly from substance-use disorders where baseline receptor availability and dopamine release are typically reduced. Interestingly, the mu opioid receptor targeted by medications for gambling disorder showed mixed results. Therefore, while medications targeting the mu opioid receptor have been explored for the treatment of gambling disorder, the mixed findings indicated here imply that the outcome from the use of such medication is uncertain.

2.4.4 Neural systems can work together to increase the risk of harmful gambling

While the above studies often highlighted specific regions of the brain, further evidence reviewed has highlighted the importance of neural systems that comprise different regions of the brain. García-Castro et al. (2022) reviewed the neurophysiological findings on cue-reactivity, with results highlighting the importance of three neural systems (the associated brain regions explored within each system are highlighted in brackets):

- The reward system (nucleus accumbens, ventral and dorsal striatum, caudate nucleus, medial PFC, amygdala, OFC);
- Learning and memory systems (amygdala, hippocampus, grey matter, OFC, right middle insula); and
- Executive function systems (amygdala, anterior insula, caudate nucleus, dlPFC, frontomedial PFC (fmPFC), medial PFC (mPFC), PFC, OFC, right MFG, medial frontal gyrus, nucleus accumbens, right frontal orbital cortex, right hippocampus, ventral medial prefrontal).

In terms of the reward system, several papers reviewed by the authors highlighted the role of the nucleus accumbens and striatum in craving, anticipation and reward processing for participants with gambling disorder, but not to erotic stimuli. The authors suggested that findings support the sensitising theory where, despite the high involvement of reward pathways to gambling stimuli, there are decreased neural responses associated with natural reinforcers. In other words, although gambling-related cues may stimulate the brain’s reward system, the brain’s responses to other rewards decrease. Furthermore, there is some evidence for increased craving being related to reduced connectivity between ventral striatum and the media prefrontal cortex. Moreover, regions of the brain related to executive functions (OFC, dlPFC, mPFC) are more active in gambling disorders when exposed to cues as well as in anticipation, processing and decision-making tasks with rewards. Also, lower connectivity between the fmPFC and the nucleus accumbens was related to higher craving scores and reduced loss-aversion. This suggests that increased gambling-related cravings may be a function of a reduced capacity for cognitive control over reward seeking. Moreover, evidence reviewed by the authors was able to distinguish between gambling

disorder and healthy controls by stronger connectivity between nucleus accumbens and the amygdala (often associated with emotions). This stronger connectivity could mean that the brains of those experiencing gambling disorder may be more strongly influenced by gambling, making them more connected to gambling-related rewards and affecting decision-making processes.

In terms of learning and memory systems, impaired hippocampus (related to memory and learning) and amygdala (related to emotion) could be related to the maintenance of factors that prevent abstinence. Here, dysregulated affective processing and episodic memory may impact learning, association and decision-making. Ultimately, this could influence decision-making and risk aversion, such as enabling greater optimism, and be associated with the preference for risky but short-term profit seeking behaviour over less-risky long-term consequences. For instance, cognitive distortions positively correlated with limbic system activation in the right-amygdala, and stronger connectivity between the amygdala and OFC in healthy controls.

The authors also noted a key role for the insula, an area of the brain related to cognition, emotion, and bodily control where the insula acts as a 'switch' that causes executive disruptions (reduced inhibition, decision making, cognitive flexibility) in certain situations (stress, lack of sleep), leading to a motivation to seek immediate rewards. This finding is consistent with other models of addiction. In this sense, the insula connects all three systems and modulates attention processing to gambling stimuli, modulates connectivity to learning centres and plays a role in selective reward enhancement. In sum, according to the evidence reviewed, individuals with gambling disorder appear to be hypersensitive to craving, anticipation and processing of gambling-related rewards, which may be a function of the reduced connectivity that facilitates executive control of reward processing.

Additionally, more meaning is attached to the potential and actual rewards as there are stronger connections between affective processing regions and reward pathways. It is also harder for individuals with gambling disorder to learn which behaviours are risky. This is because the impaired function of the memory system and affective processing make it difficult for individuals to learn the risks associated with their decisions and creates a bias towards risky behaviour and less regard for potential long-term consequences. Finally, individuals experiencing gambling disorder were shown to have insula function comparable to other addictive conditions where situations such as being under stress can cause disruption to decision-making processes, thus leading to immediate reward-seeking behaviour.

2.5 Neuropsychological conditions

Our scoping review also found that harmful gambling can co-exist with neuropsychological conditions that may be genetically predisposed, or a consequence of environmental interaction (for example, traumatic head injuries, alcoholism). Our scoping review found research that explored the co-existence of harmful gambling alongside a wide range of individual

neuropsychological conditions, as well as a range of conditions explored within the same review.

2.5.1 Harmful gambling in Parkinson's disease is associated with forms of treatment

Djamshidian et al. (2011) reviewed the literature on pathological gambling in Parkinson's disease. They conclude that pathological gambling is a serious but uncommon complication related to the dopamine agonist therapy for Parkinson's disease. Dopamine agonist therapy has the potential to stimulate dopamine receptors in the brain's reward system, potentially impacting gambling-related cognitions like decision-making processes and increasing impulsivity. In line with this, fMRI studies have found a down regulation of the frontostriatal connections and upregulation of striatoinsular connections; together this increases impulsivity. Like non-clinical populations, in Parkinson's disease, the risk factors associated with developing pathological gambling included male gender, previous alcohol or substance abuse, history of depression, and novelty-seeking personality traits. Also, those living with young-onset Parkinson's disease who are unmarried and/or smoke are vulnerable, especially if they have a family history of addictive disorders. Patients living with Parkinson's disease who are also experiencing 'problem gambling' are more likely to be aggressive, disinhibited, have an eating disorder and show antisocial behaviour. They are more likely to make risky decisions and are less able to delay gratification. The authors suggest that 'problem gambling' is caused by increased impulsivity, poorer self-control and proclivity for risky behaviour that is dialled up by dopamine agonist therapy, rather than a hypersensitivity to rewards.

Conversano et al. (2012) reviewed biochemical, neuroimaging and neuropsychological findings of previous studies into the neurobiological aspects of pathological gambling. Regarding biochemistry, they note that 'pathological gambling' has been seen in conjunction with dopaminergic disorders such as Parkinson's disease, particularly when using dopamine agonists. Other neurochemicals have been implicated such as serotonin, norepinephrine and opioids, although evidence was still emerging, and the precise roles remain unclear. There is some evidence that the activation of the stress-response pathway could be implicated more strongly in 'pathological gambling'. FMRI studies highlight dysfunction in regions of the brain that process expectations (reflecting the prediction of reward, based on observed probabilities or stimulus reinforcement), compulsions (repetitive behavioural strategy despite the lack of reward linked to a stimulus), and decision-making (balancing expectations against stimulus-associated rewards or reinforcing probabilities).

Santangelo et al. (2013) reviewed the literature on 'pathological gambling' in Parkinson's disease across a variety of areas: prevalence, clinical and behavioural features, cognitive function, genetics, neuroanatomy and treatment. Prevalence rates of 'pathological gambling' ranged from 2.2% to 7%. Developing 'pathological gambling' in Parkinson's disease was strongly

associated with dopamine agonist treatment, especially in younger males with previous family history of gambling problems, alcohol and/or substance use. ‘Pathological gambling’ was also associated with using tobacco, caffeine, motor complications, higher peak dopamine agonist dosage, novelty seeking and high impulsivity. There is also evidence of frontal and executive dysfunction, particularly impairments in decision-making in ambiguous or risky situations, although evidence remains scarce. The genetic influences on developing ‘pathological gambling’ in Parkinson’s disease are still unknown. In terms of neuroanatomy, ‘pathological gambling’ seems to develop in Parkinson’s disease due to abnormal reward-based learning processes and reduced inhibition of impulsive drives, combined with dopamine overstimulation in pathways related to rewards and emotions.

Grall-Bronnec et al. (2016) reviewed the effect of dopamine replacement therapy (DRT) or Aripiprazole (ARI), a treatment that affects dopamine in the brain. Patients in the ARI group reported more severe pathological gambling than the DRT group. This suggests a role for dopamine in the initiation of harmful gambling via impulsivity and control disorders. There was, however, only mixed evidence in relation to the dose-effect relationship. There are also many other factors that contribute to adverse drug reactions like substance-use disorders, mood or psychotic disorders or prior regular gambling, as generally it is only a minority of patients with Parkinson’s disease that develop gambling disorder. Finally, Molde et al. (2018) performed a meta-analysis on studies reporting on Parkinson's disease and impulse control disorders. They found that gambling was significantly related to Parkinson's disease, specifically in patients being medicated. In summary, the evidence uncovered during our scoping review indicates that harmful gambling in Parkinson’s disease is associated with forms of dopamine-related treatment.

2.5.2 Individuals living with ADHD are more likely to experience harmful gambling

One review found evidence of the heightened risk of harmful gambling amongst individuals living with ADHD. Theule et al. (2019) examined the link between ADHD and gambling through a meta-analysis of 24 research papers (including 20 journal articles, one unpublished report, and three doctoral theses or dissertations). The authors found a significant correlation between ADHD symptoms and ‘problem gambling’ (as measured mostly by SOGS and DSM-IV). In ‘problem gamblers’, the ADHD prevalence was 18.46% across the sample, and 11.75% of those with ADHD were likely to experience ‘problem gambling’. Put another way, ‘problem gamblers’ were 4.18 times more likely to have ADHD, and those with ADHD were 2.85 times more likely to experience ‘problem gambling’.

2.5.3 There is a strong relationship between harmful gambling and obsessive-compulsive traits

The sample also included one review of research exploring the association between harmful gambling and obsessive-compulsive disorder (OCD). Durdle et al. (2008) reviewed the literature and performed a meta-analysis on the relationship between 'pathological gambling' and OCD. They found a strong relationship between sub-clinical obsessive-compulsive traits and 'pathological gambling' (compared to non-pathological gambling). Significantly smaller effect sizes were found between clinical OCD and 'pathological gamblers', suggesting that relative to controls, 'pathological gamblers' did not show higher rates of either OCD or obsessive-compulsive personality disorder. Neither does there appear to be familial links between 'pathological gambling' and OCD, which would be expected if there was truly a relationship between them. The explanation of the relationship between sub-clinical obsessive-compulsive traits and 'pathological gambling' is potentially due to measurement overlap with components such as preoccupation and compulsivity.

2.5.4 The relationship between harmful gambling and personality disorders is unclear

Bagby et al. (2008) reviewed the literature on personality disorder prevalence in 'pathological gambling'. Prevalence rates of borderline personality disorders and antisocial personality disorders ranged from 0% to 57%. For personalities more generally, the lowest estimate was 25% and the highest was 93%. However, confidence in these estimates was low. The authors highlighted the significant inconsistencies in prevalence estimates and suggested that they varied considerably due to modes of assessment, treatment-seeking versus non-treatment-seeking samples, and comparison groups. Another significant limitation was that none of the studies controlled for mental health or substance use conditions.

2.5.5 Alcohol appears to have no impact on risk-taking while gambling

Horn et al. (2022) reviewed research examining the impact of alcohol consumption on risky gambling behaviour. Interestingly, the authors concluded that there were no consistent effects of alcohol consumption on risk-taking while gambling; because of the large-scale and complicated effects of alcohol on the brain, consumption leads to various, individual effects that for some will increase risk taking and for others decrease it. Importantly, the blood alcohol levels in the studies evaluated were broad and there thus remains

unanswered questions surrounding the moderating effect of level of consumption. Interestingly, there was no difference between groups consuming alcohol and groups consuming a placebo or non-alcoholic drink, but there was between non-alcohol and placebo groups. This suggests that the increased risk-taking may be due to participant expectations rather than the pharmacological effect of having consumed alcohol itself.

2.5.6 There is an association between childhood maltreatment and later harmful gambling

Lane et al. (2016) examined the relationship between childhood maltreatment and later gambling problems. The authors found – despite the differences in populations studied across the studies within their review – a strong association between childhood history of maltreatment and subsequent 'problem gambling'. With all maltreatment combined, those experiencing 'problem gambling' had significantly higher scores on the childhood trauma questionnaire after controlling for family function, antisocial features, stress, alcohol and drug dependency. In terms of sexual abuse specifically, five of seven studies reported significant associations with odd ratios ranging from 2.01 to 3.65. There were some mixed effects in relation to potential gender differences in the association. In terms of physical abuse, three of four studies found a significant association, with odds ratios between 2.3 and 2.8, yet when controlling for mental health diagnoses, this association remained in only one of the studies and only for pathologic gamblers. In terms of neglect, significant associations are found in two out of three studies when controlling for sociodemographic variables. When controlling for mental health disorders, this association reduced, as it did also for emotional abuse. It is likely that mental health is an important mediator in the development of 'problem gambling', or that maltreatment increases the likelihood of both 'problem gambling' and mental health conditions.

2.5.7 Conduct problems are a risk factor for harmful gambling

Richard et al. (2020) explored the links between conduct problems, depressive symptoms and 'problem gambling' through a systematic review of 71 studies. The authors concluded that conduct problems were a risk factor for problem gambling. They suggested this was indicative of co-occurrence and shared etiology, such as impulsivity and disinhibition, rather than causal. They also noted some evidence for greater depressive symptoms in those experiencing problem gambling, even when controlling for other psychosocial and demographic variables. However, the authors found that the longitudinal evidence linking depressive symptoms with 'problem gambling' was mixed, although the trend was towards depressive symptoms being a poor predictor of 'problem gambling'.

2.5.8 Harmful gambling can also co-exist with a range of neuropsychological conditions

We uncovered research which has explored the co-existence of harmful gambling behaviours with a range of other neuropsychological conditions. Over a decade ago, Scholes-Balog et al. (2012) reviewed the literature into online gambling, substance use and mental health. They concluded that there was growing evidence that online gambling is associated with poorer mental health and greater substance use, as had already been established for venue gambling. However, at the time, the strength of these relationships was unclear. When comparing online and venue gambling, they reported an emerging trend for more alcohol-use disorder in online gamblers. In another review focusing on online gambling, Mora-Salgueiro et al. (2021) were interested in demographics and clinical comorbidities of problem online gambling. They report that the 'typical' online 'gambler' is a single, 30–40-year-old man with a secondary school education. In terms of clinical comorbidities, the only consistent associations were with mental health conditions, as well as alcohol and substance use.

In terms of gambling more generally, Loo et al. (2019) reviewed 51 studies that used representative US samples. They reported that increased likelihood of 'problem gambling' was associated with being male, black, between 45-64, and widowed, separated, or divorced. Relationships were also found with substance dependence, mood disorders, personality disorders (particularly anti-social personality), comorbid diagnoses (especially among females) and suicide attempts. Higher income also increased the association between problem gambling severity and alcohol dependence. Interestingly, recreational gambling among older adults over 65 was related to better self-reported physical and mental health. Other than these older participants, there was no indication that the age of gambling onset was related to pathological gambling.

Peters et al. (2015) explored the association between gambling and other risky behaviours in adolescence: tobacco, alcohol and substance use. Gambling prevalence ranged from 22% to 86% depending on the type of survey method. Most papers reviewed by the authors found significant associations between gambling and tobacco, alcohol and illicit drugs use. The weakest association was for tobacco, where three out of seven studies found no relationship. They also found relatively high rates of 'problem gambling' compared to the normal population. Thus, they highlight how interventions for youth must target a spectrum of high-risk behaviours.

Lorains et al. (2011) performed a systematic review and meta-analysis of comorbidities in 'pathological gambling' in population studies. The most prevalent comorbidities were nicotine dependence (60.1%), substance-use disorder (57.5%), alcohol-use disorder (28.1%), illicit drug use (17.2%), any mood disorder (37.9%), major depression (23.1%) and bipolar (9.8%), any anxiety disorder (37.4%), generalised anxiety disorder (11.1%) and anti-social personality disorder (28.8%). However, the authors caution that these

prevalence estimates should be considered in light of the heterogeneity of methodologies analysed.

More recently, Dowling et al. (2015) reviewed the qualitative and quantitative evidence on the prevalence of psychiatric comorbidities and 'problem gambling'. Three-quarters of treatment seeking problem gamblers displayed current co-morbid axis I disorders, or disorders in Axis I in the Diagnostic and Statistical Manual of Mental Disorders. The most common comorbid disorders were nicotine dependence, major depressive disorder, alcohol abuse and dependence, social phobia, generalised anxiety disorder, panic disorder, post-traumatic stress disorder, cannabis-use disorder, ADHD, adjustment disorder, bipolar and obsessive-compulsive disorder. The most common lifetime disorders were major depressive disorder, alcohol and substance use disorders. Interestingly, there were lower estimates for alcohol-use disorder in 'pathological gamblers' compared to 'problem gamblers', and in US-based studies compared to European studies. 'Pathological gamblers' with alcohol-use disorder were more likely to seek help for their alcohol usage rather than gambling.

Johansson et al. (2009) reviewed studies that examined risk factors of problematic gambling. Having reviewed the literature, they found nine factors that showed support from more than two studies. These were age, gender, cognitive distortions (erroneous perceptions, illusion of control), sensory characteristics, schedules of reinforcement, comorbid states (obsessive-compulsive disorder, drug abuse), and delinquency or illegal behaviours. In summary, the research reviewed here highlights how harmful gambling can correlate with multiple neuropsychological conditions.

2.6 Conclusion

This chapter has explored the biological factors that are associated with the initiation of harmful gambling. Our scoping review found that genetic factors can play an important role in mediating the motivations or perceptions involved in the initiation of harmful gambling. Additionally, harmful gambling can be associated with increased reward seeking, reduced cognitive control, and increased dopamine release. Relatedly, harmful gambling can be associated with dopamine treatment for Parkinson's disease. Indeed, harmful gambling can present alongside a range of neuropsychological conditions. There is for example, an association between ADHD and harmful gambling, OCD and harmful gambling, and childhood maltreatment and later harmful gambling. However, it should be noted that the cross-sectional nature of the data, in addition to a lack of ecological validity (for example, lack of gambling in real-world settings or gambling-related cues), means that while associations between certain biological factors and harmful gambling can be made, establishing causation can be tricky in the absence of longitudinal data.

3 Psychological and cognitive factors

Chapter Summary

- This chapter explores the relationship between harmful gambling and psychological, cognitive, and other individual factors.
- The evidence base was formed of 27 reviews of extant literature. Again, this was formed of mostly quantitative data, with little longitudinal data.
- Alexithymia (the inability to accurately describe, conceptualise, and feel emotions) has been shown to increase the risk of harmful gambling.
- Separately, those who experience harmful gambling are more likely to feel greater arousal from gambling-related stimuli. Harmful gambling has also been associated with specific personality traits, such as neuroticism (associated with negative emotions)
- Research has also uncovered cognitive aspects which can affect the decision-making processes of those at risk of harmful gambling. Stress can contribute to – and be caused by – harmful gambling, while harmful gambling is associated with high impulsivity and low inhibition. Heavier gambling can also be associated with reduced perceptions of risk, while cognitive distortions (irrational thoughts that can influence our emotions) are associated with harmful gambling.
- There are wider individual differences – notably age and financial motivations - which can affect the perceptions, motivations or decision-making processes in relation to harmful gambling. The evidence shows that young people perceive gambling as normal and increasingly accessible, for example. Financial motives can be associated with harmful gambling as well.

3.1 Introduction

This chapter reviews the evidence that links the psychological, cognitive, and wider individual differences that may result in individuals being at heightened risk of initiating harmful gambling. These factors all play a role in – or at least explain - the perceptions and motivations that may lead to gambling, for example, through the internal and external perceptions which are shaped by cognitions related to gambling, or through factors that may explain how motivations to gamble may be intrinsic (for the enjoyment of gambling) or extrinsic (for example, through escapism or reward). Additionally, individual differences such as financial motivations, the impact of social networks, and the accessibility of gambling can also have an impact on the individual. However, as the chapter explores, the evidence reviewed was mostly cross-sectional, and such factors can also be considered as correlates of, or co-existing with, harmful gambling. There is a lack of longitudinal data, and the evidence linking such factors to harmful gambling is not always clear.

We begin this chapter by describing the evidence base, before reviewing the evidence associating psychological characteristics with harmful gambling. We then explore the cognitive features that were also associated with harmful

gambling in our scoping review. Finally, we review the wider individual differences that may impact gambling behaviours.

3.2 About the evidence base

The evidence base exploring the psychological, cognitive, or other individual factors that may increase the risk of harmful gambling was formed by 27 reviews. As with the previous chapter, these reviews explored mostly quantitative studies, although there was a higher number of reviews of qualitative studies (Spurrier and Blaszczynski, 2013; Wardle, 2018), or reviews based on both quantitative and qualitative data (Tse et al., 2012; Nordmyr and Forsman, 2020; Rogier et al., 2021a). The sample also included one review based on empirical trials (Chretien et al., 2017) and one based on research which included at least one family variance variable and one gambling measure (McComb and Sabiston, 2010). The sample sizes of reviews ranged from five individual studies (Reynolds, 2006) to 65 individual studies (Nowak et al., 2018). Most of the evidence was cross-sectional, while the ages and gambling severity of the research populations varied across the sample of literature.

3.3 Psychological traits

Our scoping review uncovered research which explored the relationship between psychological traits and harmful gambling. Three psychological traits emerged during our scoping review, highlighting the research exploring the links between harmful gambling and alexithymia, personality, and arousal. All of these psychological factors can be associated with the perceptions and motivations that lead to harmful gambling behaviours.

3.3.1 Alexithymia increases the risk of gambling-related problems

Alexithymia refers to the inability to accurately describe, conceptualise, and therefore feel, emotions. Marchetti et al. (2019) systematically reviewed the relationship between alexithymia and gambling problems. They reported a dose-response relationship between alexithymia and gambling-related problems with a prevalence of alexithymia in between 31% and 52% of ‘pathological gamblers’ in the community and between 31% and 67% in clinical samples diagnosed with gambling disorder. The authors concluded that alexithymia is likely to associate with gambling as a coping behaviour to increase arousal and avoid negative emotions. The authors suggest that alexithymia may increase symptom severity and the risk of ‘problem gambling’. Finally, there were clinically significant interactions with maladaptive personality (sensation-seeking, impulsivity, aggressiveness), psychopathological (depression, anxiety, and traits of personality disorder), and cognitive (gambling-related cognitions, motivation, strategic, and non-strategic games) factors. This is not unlike the alexithymia findings in other

use disorders, especially related to cravings and urges. The authors argued that alexithymia explains addictive behaviour and is not a secondary characteristic of toxic substance effects. As alexithymia is a deficit in the self-regulation of affect and other bodily cues, it might be that activities like gambling are used to regulate or have control over emotional states. Of course, gambling behaviour is not an all-or-nothing phenomenon and is shaped by modes of play, and many other influencing factors. Therefore, those who play active or skill-based games (for example, poker) might play for emotional arousal and sensation seeking while high-alexithymic individuals might instead use passive games (for example, slots games) to cope with negative emotions due to gambling losses.

3.3.2 Harmful gambling can be associated with specific personality traits

MacLaren et al. (2011) performed a meta-analysis to understand the relationship between measures of personality and problem or non-problem gambling. Studies compared 'pathological gambling' and 'non-pathological gambling' groups that were similar in age and gender, and drawn from a variety of settings, using self-report and clinical interview methods for determining gambling status. 'Pathological gambling' was associated with unconscientious disinhibition and low premeditation, negative affect, negative urgency, and disagreeable disinhibition. They found no reliable associations between 'pathological gambling' and positive emotionality, low perseverance, or sensation-seeking forms of impulsivity. Unconscientious – or unintentional - disinhibition and low premeditation align with 'pathological gambling' as an impulse control disorder or behavioural addiction. The moderate association between 'pathological gambling' and unconscientious disinhibition supports the view that 'pathological gambling' is an externalising behavioural addiction. In conclusion, the personality profile associated with 'pathological gambling' is similar to that found in meta-analyses of borderline personality disorder and substance-use disorders for which the combination of negative affect with unconscientious and disagreeable disinhibition is a risk factor. The authors conclude that 'pathological gambling' should therefore be considered as an externalised behaviour, and not classified as an Impulse Control Disorder within the Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition, DSM-IV).

Strømme et al. (2021) performed a systematic review and meta-analysis of the association between gambling-related problems and the five-factor model of personality (personality traits of agreeableness, conscientiousness, extraversion, openness to experience, and neuroticism). The two strongest correlations to 'problem gambling' were found to be a negative association with conscientiousness and a positive association with neuroticism. The authors also found negative correlations between 'problem gambling' and agreeableness, openness, and extroversion. In terms of neuroticism, the relationship is likely bidirectional as gambling may arise as a distraction from anxiety, as an escape from dysphoria (for example, nervousness, depression,

guilt, frustration, and self-consciousness), as well as financial and interpersonal harms leading to feelings of guilt and anger which would increase neuroticism. As for low conscientiousness, gambling has been related to disorganised personal lives and difficulty following personal aims or considering long-term consequences. On the other hand, other studies found that partaking in risky behaviour can also decrease scores related to conscientiousness, defined by the authors as “the will to achieve, and people with high scores on this trait are typically described as thorough, neat, well-organized, achievement-oriented, and able to hold impulsive behavior in check” (Strømme et al, 2021, p. 2). Those low in agreeableness are characterized by being competitive, challenging, and less cooperative, with competitiveness particularly linked to gambling behaviour. Conversely, highly agreeable people tend to avoid interpersonal conflict and therefore avoid ‘problem gambling’ behaviours. Alternatively, ‘pathological gambling’ could reduce agreeableness as problems increase focus on self and lessen focus on others. Socio-economic status also predicted ‘problem gambling’ and low openness.

Dudfield et al. (2022) performed a meta-analysis on the five-factor dimensions of personality and ‘problem gambling’ scores. They found that ‘problem gambling’ was associated with high neuroticism and lower scores on conscientiousness, agreeableness, openness and extraversion. Effect sizes for neuroticism (9.6%) and conscientiousness (7.84%) were moderate, while the effect sizes for others were small. The authors suggested that ‘problem gamblers’ experiencing high neuroticism may use gambling to escape the associated negative feelings such as worry, anxiety, depression and self-consciousness. Low conscientiousness involves apathy, impulsivity and disregard of norms. The authors argued that impulsivity could play a factor in ‘problem gambling’ through its focus on short-term rather than long-term outcomes. Low agreeableness was commonly an antecedent of relationship and occupational dysfunction, consequences characteristic of gambling disorder – low agreeableness was also associated with competitiveness. Low-openness is related to change-avoidant characteristics which would contribute to persistent gambling. Low extroversion was often related to poor emotional regulation strategies, thus suggesting that gambling was also used as a form of emotion control.

3.3.3 Those experiencing harmful gambling feel greater arousal from risky or gambling-related stimuli

In relation to general arousal, Biback and Zack (2015) found that simply viewing risky videotapes (for example, videos of rollercoaster rides) evoked gambling urges in ‘pathological gamblers’, but not in abstinent or non-’pathological gamblers’. Additionally, increasing arousal in ‘non-pathological gamblers’ can increase bet size, but conversely reduce bet sizes by ‘pathological gamblers’. Furthermore, Baudinet and Blaszczynski (2013) were

interested in how subjective and physiological arousal relates to specific modes of gambling. In most studies, participants were not exposed to non-preferred gambling stimuli and no comparisons were made between modes. However, in the two eligible studies, horse race bettors and lottery gamblers exhibited cue-specific physiological and subjective arousal to gambling cues. This suggests that people who gamble may respond differently to preferred gambling cues compared to non-preferred gambling cues. Also, gamblers displayed greater reactivity in arousal to gambling-related cues compared to non-gamblers, but there was no difference in relation to gambling severity. The authors also found that electronic gaming machine (EGM) players' subjective arousal in response to EGM play or related cues increased according to gambling severity. Alternatively, more severe problem card bettors experienced higher physiological arousal but not subjective arousal towards card-betting stimuli. This provided initial evidence pointing to the importance of including product-specific stimuli to avoid false negative results in experimental settings.

3.4 Cognition

Our scoping review also uncovered the role of individual cognitions in the shaping of decision-making processes in relation to the initiation of gambling. These reviews explored individual, cognitive functions. They therefore do not address neurophysiological or psychological factors, rather focusing on the mental processes that lead individuals into certain actions, in this case harmful gambling. Our scoping review uncovered numerous factors that may impact the association between individual cognition and the initiation of harmful gambling.

3.4.1 Stress can contribute to – and be caused by – harmful gambling

Stress is a non-specific response of the body to environmental demand, characterised by deviance from homeostasis. The impact of stress can be nuanced depending on additional factors, and there is evidence that stress can impact gambling behaviour in a number of ways. Biback and Zack (2015) reviewed research between stress and motivation in 'pathological gambling', where they found that stress can contribute to 'pathological gambling', as well as highlighting the stress-like effects that gambling can have on the body. From experimental studies on decision-making, the authors found evidence that stress impairs performance on the Iowa Gambling Task. The Iowa Gambling Task is a psychological test used to assess decision-making abilities by simulating real-life decision scenarios involving risk and reward, where participants must select the most profitable decks of cards amongst others by tracking the probabilities associated with each and learning which is the most profitable over time. They also found that pre-exposure to stress reduced the tendency to gamble after a win or loss, which is dubbed "the reflection effect". However, a limitation was present in that experimental tasks

were forced-choice scenarios and did not provide options that correspond to decisions to continue gambling.

As for dispositional or developmental sources of stress, stress reactivity had considerable individual differences and for complex tasks there was an inverted-U relationship between baseline-arousal and effects of a stressor. Low baseline stress equalled better performance when environmental stress was high, while high baseline stress resulted in better performance when environmental stress was low. In summary, participants with low heart rate made faster and riskier decisions in gambling tasks and perceived risky options as less arousing than those with high heart rate.

In terms of psychological conditions, panic, generalised anxiety disorder and post-traumatic stress disorder were all associated with high rates of 'pathological gambling'. The authors suggested that this might be explained by general adaptation syndrome where, regardless of baseline arousal, prolonged exposure to stress will lead to deficient performance as compensatory stress response begins to fail and exhaustion begins. However, gambling may reverse deficient arousal through the setting of high stakes, but this then ignites a need for even greater arousal and allostatic baseline drops even lower, explaining the cycle of escalating gambling behaviour.

In terms of the effects of gambling, casino gambling increased norepinephrine and saliva cortisol (both stress hormones) in 'non-pathological gambling' participants and was accompanied by elevations in heart rate. Importantly, norepinephrine – a neurotransmitter that plays a key role in the regulation of reaction to different situations - and heart rate effects were also reported to be more pronounced and persistent in participants experiencing 'pathological gambling'. Furthermore, 'pathological gambling' was associated with hypofunctional norepinephrine receptors which decline progressively in function with more gambling exposure. Thus, greater neurochemical response during gambling coincides with greater neurochemical deficits in the absence of gambling. Relatedly, during the expectation of reward, participants experiencing 'pathological gambling' have severity-dependent decrease in amygdala activation. Norepinephrine release in amygdala – an area of the brain related to processing emotions - mediates the ability to learn to avoid activities due to experiences of previous detrimental consequences. This hyposensitivity to norepinephrine signals reduces the effect of somatic markers that might otherwise deter riskier decisions during gambling. To summarise, gambling reduces the function of receptors leading to progressive stress dysregulation and exhaustion.

3.4.2 The association between attentional bias and harmful gambling is unclear

Attentional biases towards stimuli related to addictive disorders have been demonstrated previously, such as the bias towards alcohol-related stimuli in alcohol use disorder. Crucially, if an individual has an attentional bias towards certain stimuli, then this may impact: the number of urges that are triggered;

their perception of the presence of addictive cues in their environments; and their ability to control urges or disengage from addictive cues. Hønsi et al. (2013) reviewed the evidence of attentional bias towards gambling-related stimuli in 'problem gambling'. Seven of eleven included studies reported attentional bias in 'problem gamblers'. Attentional biases were documented across all studies at the encoding level, during initial orientation, during maintenance of attention as well as delayed disengagement of attention. Overall, though, the authors concluded that there was mixed evidence for the role of attentional bias in 'problem gambling', but they noted that this was likely due to methodological issues (for example, not accounting for gambling preference) or with the validity of measures themselves. However, attentional biases were importantly not purported to be a causal factor in the addictive nature of the condition but rather something that maintained the behaviour and perhaps exacerbated severity. The authors suggested that future implications could be to develop 'attentional bias modification' training for people who gamble, thus helping them reduce their biases, control and disengage with gambling-related stimuli.

3.4.3 Harmful gambling is associated with high impulsivity and low inhibition

Impulsive behaviour is typically carried out without forethought or consideration of consequences. In relation to gambling, impulsive behaviour may omit weighing up the reward or sensation seeking of wagering money against potential long-term impacts such as negative financial consequences. Kovács et al. (2017) examined decision-making in gambling disorder using the Iowa Gambling Task. Typically, healthy persons would be expected to learn the outcome of selecting specific decks after approximately 40 to 50 trials. In summary, players learn that - for the best performance - they must abandon short-term advantageous but riskier decisions that are disadvantageous in the long-term, for lower immediate rewards but lower long-term losses. Crucially, those who score high on impulsivity may never learn these outcomes and finish the game with a loss. The results of the authors' meta-analysis suggested that impaired decision-making was more likely amongst individuals experiencing gambling disorder than healthy persons, and that the gap is even bigger than between healthy controls and participants with alcohol-use disorder. The authors suggest that this could be indicative of favouring immediate reward and sensation seeking over future negative consequences or long-term thinking. The authors suggest that it is likely not gambling (or alcohol in alcohol-use disorder) itself that underpins this impaired decision-making but trait impulsivity, personality traits such as neuroticism or conscientiousness, or the effects of mood disorders or other psychiatric disorders that lead to the impulsive behaviour profiles.

A separate meta-analysis of 20 studies looking at motor impulsivity in 'pathological gambling' found generally elevated motor impulsivity compared to healthy controls (Chowdhury et al., 2017). In summary, those experiencing 'pathological gambling' were more likely to experience difficulty in withholding

or cancelling inappropriate responses, and “may account for the inability for pathological gamblers to inhibit their urges to gamble” (Chowdhury et al., 2017, p. 1213). The authors found moderate to large effect sizes for higher self-reported impulsivity and greater difficulty stopping an initiated response during specific tasks. Interestingly, ‘problem gamblers’ also demonstrated poorer sustained attention, were slower to respond to signals when no inhibition was necessary and were more likely to fail to execute an appropriate response. Therefore, although deficits were apparent on tasks typically associated with inhibitory control and impulsivity, the authors suggest that this profile of results may be more likely indicative of a generalised deficit in executive and cognitive control, rather than motor impulsivity specifically. Therefore, individuals experiencing ‘problem gambling’ may be unable to resolve conflicts between ‘stimulus-driven’ or ‘automatic’ and ‘voluntary’ responses (for a similar discussion, see Smith et al., 2014).

Impulsivity is often discussed as a single aspect of behaviour but it encompasses several cognitive functions that may impact decision-making. Ionnidis et al. (2019) conducted multiple meta-analyses on various components of impulsivity. They report the first meta-analytical evidence of elevated impulsivity for motor inhibition, attentional inhibition, delay discounting, and decision-making. In gambling disorder, impulsivity is evident across the whole spectrum of well validated cognitive tasks. The authors concluded that characteristics that lie beneath these factors are associated with – and therefore make individuals more susceptible to – ‘problem gambling’. This would also explain large comorbidity rates, although the authors found no significant moderation effects of comorbidities.

Amlung et al. (2016) performed a meta-analysis on studies examining delayed reward discounting (DRD) in gambling addiction. DRD can be defined as “the subjective devaluation of rewards based on their delay in time” (Amlung et al., 2016, p. 51). In other words, DRD reflects how a reward’s value can be discounted based on its delay in time (see also MacKillop et al., 2011). Amlung et al. (2016) found a significant association between DRD and gambling addiction, albeit with a small effect size. Steep DRD – or the prioritisation of immediate over delayed rewards - was related more strongly to severity of addiction compared to quantity or frequency of behaviours. Impulsive choices behaviours were more related to the experience of negative consequences. DRD can also be considered as a risk factor for engaging in gambling, a consequence of prolonged engagement, or a combination of both. However, this meta-analysis cannot demonstrate causality. It also hard to understand how much gambling specifically can be distinguished from the other behaviours that co-occur.

Reynolds (2006) also explored delay discounting, specifically related to the speed-of-play. The author found that ‘non-pathological gamblers’ discounted less, while those experiencing comorbid ‘pathological gambling’ or substance-use-disorder discounted even more than when presenting one of these conditions alone. This demonstrates the addictive association of both disorders such that it points to a separation of underlying mechanisms contributing to delay-discounting. The association between more moderate

forms of gambling was less clear, with one study reporting an effect and one reporting no effect, likely through the differences represented in methodological differences in sample age (40 compared to 18-24), the sampling of horse-racing punters and students, and being carried out in a gambling setting and at a university computer. The review was also based on a limited sample.

3.4.4 Compulsivity can characterise harmful gambling

Compulsive behaviour is typically rigid, repetitive and follows urges to act. Van Timmeren et al. (2018) conducted a meta-analysis of compulsivity-related neurocognitive tasks in individuals with gambling disorder compared to healthy controls. Their results indicated performance deficits in a broad range of compulsivity-related functions in gambling disorder. In summary, compulsivity-related performance deficits characterise gambling disorder. There were however mixed results in cognitive flexibility studies. Participants experiencing gambling disorder performed significantly worse than control participants during in-task or attentional set shifting, while significant deficits were seen in participants experiencing gambling disorder for attentional bias or disengagement. The authors suggested that these may underpin the development and maintenance of gambling behaviour. For instance, lack of attention-switching and not being able to disengage from a behaviour could lead to compulsive gambling behaviour and inability to quit.

3.4.5 Emotional regulation is an important risk factor for harmful gambling

Marchica et al. (2019) reviewed the evidence on the relationship between emotion regulation and behavioural addictions. Twelve of the fourteen studies reviewed that explored the relationship between emotional regulation and ‘problem gambling’ reported significant relationship between the two aspects, indicating that emotional regulation is an important risk factor for gambling problems. However, the type of gambling activity may be an important moderator between using suppression as an emotion regulation strategy and gambling disorder. For example, ‘strategic gamblers’ who played games such as poker used suppression more, compared to ‘mixed gamblers’. Four studies reported large effect sizes with some evidence that maladaptive emotion regulation such as catastrophizing and self-blame are strongly associated. Another six studies reported medium effect sizes, with reappraisal strategies significantly lower among problem gamblers, and suppression higher.

3.4.6 Heavier gambling can be associated with reduced perceptions of risk

Spurrier and Blaszczynski's (2014) review explored the relationship between risk perception and gambling behaviour. Evidence suggested that heavier or more 'disordered gamblers' have more positive views about expectations from gambling – for instance, favourable attitudes are related to more time and money spent. Furthermore, stronger expectations of positive outcomes such as excitement or financial reward, as well as negative outcomes such as a loss of control are related to higher frequency and more 'disordered gamblers', at least amongst adolescents. Both positive and negative expectancies can be important predictors of gambling behaviour and problems, although positive expectancies – especially emotional arousal – are more significant affecters of decision making than perception of negative outcomes.

In terms of the role of outcome expectancy in decision-making and behaviour, 'disordered' or 'higher frequency gamblers' reported more optimistic outlooks on gambling. Thus, optimism may lower relative risk estimation, resulting in poor management of resources such as time and money. Alternatively, high investment in gambling may lead to under-reporting or lack of insight into risks to justify behaviour. Moreover, research suggested that 'disordered gamblers' may give more weight to positive-over-negative outcome expectancies based on greater personal significance or salience of positive outcomes.

Another possibility is that gambling urges may overwhelm consideration of consequences, even though 'disordered gamblers' also expect more negative consequences. Interestingly, negative expectancy amongst 'low-risk' or 'non-gamblers' likely protects by reducing motivation which then leads to less awareness of possible losses or gambling-related problems. Of particular interest were the demographic, socio-cultural and cognitive-behavioural factors that determined beliefs. For instance, younger individuals and males were correlated consistently with optimistic risk perception (through enjoyment, arousal, or money), while females had stronger perceptions of harm (for example, emotional impact). Overall, attitudes and decisions are subjective and are based on what is important or salient to individuals, based on cultural experiences, mental states and other individual differences. For instance, the 'escape' dimension on the Gambling Expectancy Questionnaire was associated with both positive and negative emotional scales.

With regard to factors that influence the role of risk perception in decision making and behaviour, it was noted that positive outcomes, compared to negative outcomes, were often more immediate and direct which resulted in them being more powerful reinforcers. Also, lower risk estimation was related to greater gambling involvement and psychopathology. Some evidence pointed to the importance of mental states such as subjective arousal, as well as to environmental factors (especially when vulnerable) in triggering gambling urges, emotion and expectations.

Finally, regardless of individual, cognitive biases, the authors found that all 'gamblers' held a poor understanding of the mechanics of determining

outcomes. Also, individuals are motivated to continue gambling for positive expectations but also to reduce negative emotions, which can explain the pattern of results that place overreliance on positive outcomes but greater acknowledgement of risks.

The authors noted several general limitations of the gambling risk perception literature. For example, very few studies evaluated or referred to risk perception (alternatively, many addressed other forms of addiction and cognitive distortions). Thus, most studies reviewed made only tangential reference to risk perception. There were also common methodological issues. First, all articles were cross-sectional so no causation can be established. Several studies included indirect or no measurement of gambling psychopathology or gambling behaviour which precluded the review of these. All studies relied on self-report and subjective data and some of these only relied on a small selection or even a single item on a questionnaire (that were not tested for reliability or validity). Finally, specific and non-representative samples were used. Many of the sample restrictions related to key risk-factors and so results cannot be generalised to subpopulations.

3.4.7 Cognitive distortions are associated with harmful gambling

Rogier et al. (2021a) reviewed and meta-analysed the relationship between gambling disorder and metacognition, or the knowledge about one's cognitive process and their conscious regulation. They found that beliefs concerning the need to control are powerful predictors of the severity of gambling disorder. The authors suggest the links between gambling disorder and other metacognitive beliefs are likely to be moderated by other variables such as game-types, personality, and mood-conditions. The links between self-consciousness and gambling disorder are unclear and perhaps moderated by other variables such as public or private self-focus, negative affect, or other disorders. Also, confidence in own attention and memory was unrelated to gambling disorder and weakly correlated to 'problem gambling'. The authors concluded that while metacognition is strongly implicated in gambling disorder, to date, it has been poorly investigated and there is limited understanding of moderating variables. Some important limitations in this area included the lack of: understanding about causality; distinction between types of beliefs; no consideration of comorbidities; and no multidimensional assessment of metacognition.

Goodie and Fortune (2013) conducted a review and meta-analysis of measuring cognitive distortions in 'pathological gambling'. They concluded that across six diverse measures of cognitive distortions, they all had discriminant validity, and all were associated with 'pathological gambling' with large effect sizes. Their results support the idea that cognitive distortions are an important aspect of 'problem gambling'. All instruments revealed greater distortions amongst pathological gamblers than non-pathological gamblers. Interestingly, the 'gamblers' fallacy' (that following a loss, one will be more likely to win in the future) and the 'hot hand fallacy' (that the current outcome will be more

likely to prevail again) were both strongly associated (but not exclusively) with ‘problem gambling’. The gamblers' fallacy and the illusion of control appeared to be the most strongly supported – however, there is a broad relationship more generally between distortions and ‘pathological gambling’ such that any instrument can capture this effect. The authors at the time recommended that future research focus on how cognitive distortions such as the ‘gamblers fallacy’ or the ‘hot hand fallacy’ impact gambling problems, and how such distortions can be addressed through clinical approaches.

Chretien et al. (2017) reviewed empirical findings of cognitive restructuring interventions and found that while some thoughts such as the gambler's fallacies are important, other thoughts should also be considered, such as anticipatory (for example, “I have a real pleasure to gamble”, p. 112); relief-oriented (for example “gambling helps me forget about my problem”, p. 112); permissive (for example “only an hour of gambling, I can afford it”, p. 112); and self-control thoughts (for example “I would never be able to stop to gambling”, p. 112). Kyonka and Schutte (2018) performed a meta-analysis to examine the relationship between probability discounting (favouring large reward but low probability reinforcements) and gambling intensity and severity. They reported that probabilistic cognitive bias may underlie gambling problems. Specifically, that shallower probability discounting (for example, favouring large, low probability, or overemphasising high probability losses) is related to greater gambling intensity and is greater among problem compared to healthy controls. The authors postulated that holding these distortions could lead to maladaptive gambling behaviour via faulty reward anticipation and outcome evaluation.

Ejova and Ohtsuka (2020) proposed a classification scheme to understand the development of erroneous gambling-related beliefs (EGRBs). In a review of 40 studies, over a quarter of studies documented the ‘illusion of control’, which describes “the expectation that certain personal actions can be taken to increase the probability of ending a game of pure chance with a net win” (Ejova and Ohtsuka, 2020, p. 165). The authors argued for a distinction between primary or natural and secondary or supernatural EGRBs. They propose that erroneous gambling-related beliefs can be classified into those based on supernatural forces (routines, luck, spiritual help), randomness (gambler’s fallacy), supernatural and randomness, and natural phenomena (avoiding busy days). They suggested that because gambling activities are framed as if to posit some connection between actions and outcomes, players often reframe the activity as a problem-solving activity. The authors cited intermittent or partial rewards as meaning ‘gamblers’ are slower to abandon behaviours and beliefs, particularly if unprofitable actions suddenly become highly profitable for a period – the non-profitable actions are then reinforced in the gambler’.

3.5 Wider individual differences

In addition to the psychological traits and cognition-related factors, our search also uncovered reviews that explored the wider individual differences that may

lead individuals to be more at risk of initiating harmful gambling. These wider individual differences consist of the age or motives of the individual, or the presence of wider social support. These differences can impact decision-making particularly through their effects on the internal and external perceptions of - and motivations for - gambling.

3.5.1 Financial motives are associated with gambling frequency and harmful gambling

Tabri et al. (2022) conducted a meta-analysis on financial motives for gambling, gambling frequency and gambling severity. They found moderate associations for each, which could not be explained by covariation with other motives. Traditionally, financial motives have been seen as a positive reinforcer but not important for the transition into 'problem gambling'. However, the findings from their meta-analysis suggest that those who are experiencing significant 'problem gambling' are more likely to be financially motivated. Therefore, there may be a bidirectional relationship, also considering that there is not likely to be a single motive that drives an individual's behaviour. The authors – while concluding that financial motives are positively associated with both frequency and level of 'problem gambling' - highlight the need for more information on individual differences in attitudes to money and financial success.

3.5.2 Gambling is perceived as normal – and accessible – for young people

Wardle (2019) reviewed qualitative studies on youth gambling and young people's perceptions. The author found that research tended to focus on either young people's perceptions about gambling or what influences gambling behaviour. There were themes that cut across both, namely 'the perceptions and meaning of gambling' (p. 101), and 'factors influencing behaviour' (p. 104).

The first theme, 'Perceptions and meaning of gambling' was characterised by three subthemes: normality; nuance and ambiguity; and motivations. The subthemes reflected how gambling may be characterised in different ways. For example, gambling could be: part of everyday life; something you 'have to do at least once' (p. 101) or a rite of passage; linked closely to family and social groups; or an extension of dare or bravado. The author also highlighted the prevalence of informal betting (betting something of value, but not money), while most young people spoke about social importance of gambling, with the hope of winning money also very common. For some, gambling, and winning, was a way to exert prestige or gain status.

The second theme 'factors influencing behaviour' was characterised by five main subthemes: families, peers, places, technologies, and advertising. These

subthemes reflected how gambling was seen as a resource for shared connection, a bonding experience, and something with which young people created nostalgic memories and feelings of normality and comfort within families. Alternatively, some noted how their families felt that gambling was a 'waste of money' (p. 104), as well as ethno-cultural influences that saw gambling as an unacceptable social practice. Young people felt their networks exerted a powerful influence and were an important social resource that created social bonds or connections. Some reported that gambling added excitement to a friendly activity between friends, while others said they felt marginalized if they did not take part, especially in sporting contexts. Social benefits of gambling also seemed to outweigh potential financial consequences. As a protective factor, some suggested that changes in group could influence behaviour if they were not interested in gambling. Access and availability were perceived as important as gambling products were in venues which were attended for reasons other than gambling. Groups of boys said that they were sometimes more likely to gamble if they and a group of friends were visiting bars together where gambling machines were present. Finally, youth suggested that online gambling had brought gambling into everyday life. Young people also noted how online gambling apps could be used in situations and forums where gambling would not normally be possible.

Nowak et al. (2018) explored the moderators of gambling problems amongst college students (aged 18 to 25). They found the most prominent predictor to be male gender, with males gambling much more frequently. The association is seen in 'pathological gambling' but not in sub-clinical 'problem gambling'. In relation to ethnicity, non-White communities experienced higher rates of 'pathological' and 'non-pathological' gambling behaviour.

3.5.3 Older adults are motivated to gamble for a variety of reasons

Tse et al. (2012) reviewed the literature on gambling amongst older adults. They found establishing a prevalence rate to be difficult, although some prevalence rates were higher in certain age groups as explored within the studies reviewed by the authors (for example, circa 60 years) compared to others (for example, circa 65 years). They found that gambling was more prevalent amongst men. Older participants across the evidence reviewed by the authors were less likely to gamble to win money or escape boredom, while they also played a restricted set of games and were less likely to have other pastimes. Some of the most popular games appeared to be slot machines, bingo and lottery. Motivation to gamble was represented through five main themes: thrill of winning, socialisation, escape, enjoyment and curiosity. Other motivations included the food served at the venue, opportunities to give to charity, chances for an inexpensive holiday, the chance to take part in a 'safe way to be "bad"' (p. 645), financial motives, socialising, and escapism. Specific circumstances that motivated gambling included widowhood, low income, isolation, disabilities and health problems, rental accommodation, income supplements and inner-city living. Many groups of older adults – when

interviewed - also said they gambled for cognitive stimulation and healthy ageing reasons. The authors also found comorbidities with alcohol and substance use, post-traumatic stress disorder, and minority group status.

Subramaniam et al. (2015) explored the risk-factors, determinants and comorbidities associated with gambling problems in older adults (aged 60+). Prevalence of 'problem' or 'pathological gambling' ranged from 0.01% to 10.6%, likely due to the heterogeneity of methods. Findings showed that older adults were at lower risk of gambling problems than younger adults. The findings suggested that older adults were more likely to gamble to overcome negative emotional states as they had limited access to other exciting activities, and activities that they used to take part in were no longer accessible for them. The authors found that gambling may also offer an opportunity for socialisation. Gambling was also associated with high comorbidity such as increased stress and those who gambled were more likely than those who did not to have a lifetime diagnosis of alcohol abuse, alcohol dependence, drug abuse, major depressive disorder, dysthymic disorder, mania, hypomania, generalized anxiety disorder, panic disorder and specific phobia. Older adults with a diagnosis of lifetime gambling disorder were also more likely to have antisocial, dependent, obsessive–compulsive and schizoid personality disorder. The authors also concluded that gambling as a sedentary activity also likely attracts those with other health concerns and limited physicality. Moreover, they found that older adults who smoke and drink are also more likely to be gamblers, which might be explained by common genetic risk factors.

3.5.4 The relationship between family or wider social support and harmful gambling is unclear

The environment that may encourage the interaction of biological and psychological factors towards the initiation of harmful gambling may also include social and peer influences. This is a theme that overlaps with the experiences of gambling as a social activity, highlighted within our Challenge 2 scoping review report (Ford et al., 2024). McComb and Sabiston (2010) reviewed the literature on family influences on gambling behaviour. They reviewed five domains: (1) family sociodemographic factors, (2) general family climate, (3) parenting practices, (4) family members' attitudes and behaviours, and (5) relationship characteristics. Little association had been made between sociodemographic characteristics and adolescent gambling behaviours. However, family structural characteristics were weaker correlates (for example, socio-economic status, income, parental education) than family relational characteristics. In relation to general family climate, family problems increased with gambling severity, and increased family support was related to non- and social- gambling compared to at-risk of pathological gambling. Alternatively, other research on African American adolescents reviewed by the authors found a positive correlation between family support and gambling risk

for female adolescents only. Increased family cohesion was also related to decreased gambling. A separate study reviewed by the authors found that cohesion did not predict gambling severity once other factors like school problems, risk propensity and trait anxiety were accounted for.

In relation to parenting practices, there was no clear relationship between parental monitoring and supervision and gambling behaviour, especially once other variables are accounted for, as either protective or risk factors. Findings related to family members' attitudes and behaviours highlighted that, while parental attitudes and parental buying of scratch cards increased prevalence, little empirical research had examined the causal link to initiation. However, the robust link between frequency and severity of parental gambling was associated with adolescent gambling behaviour and was also predictive of later gambling. The evidence of the impact of sibling gambling, however, was weaker. Having family members with drug or alcohol use disorders was found to be a robust risk factor for gambling. In relation to relationship characteristics, adolescents who reported high involvement, trust, and communication (emotional support) were less likely to participate in games of skill and less likely to meet the criteria for pathological gambling. The converse was also true. Other research found that relationship quality differentiated between 'low' and 'high-risk gamblers' for females but not for males. Also, parental variables were more influential and predictive of female gambling behaviour. The authors found that no research had been done on sibling relationships.

Nordmyr and Forsman (2020) reviewed the literature on psychosocial factors (functional or qualitative aspects of networks and relationships) on gambling behaviour. They found mixed results in relation to loneliness and social support, and a difficulty in understanding the role and direction of psychosocial pathways. Loneliness and social support can both explain - and be influenced by - the association between relationships and gambling behaviour. For example, social support may moderate the association between harmful gambling and identification with peer groups. The authors also noted the influence of wider socioeconomic and political contexts in shaping individual experiences of health and wellbeing.

3.6 Conclusion

In summary, the initiation of gambling behaviours can be associated with a wide range of psychological, cognitive, and other individual factors. All of these can play a role in perceptions and motivations in relation to gambling. For example, gambling-related cognitions can be associated with reduced perceptions or risk, while gambling-related stimuli can also generate arousal within individuals. These factors impact the decision-making processes that can lead to harmful gambling. Nonetheless, as with the previous chapter, a lack of longitudinal data means that most of the factors here are again reported as jointly prevalent with harmful gambling, but caution should be exercised in claiming causality.

4 Interaction between factors

Chapter Summary

- This chapter reviews the included evidence that explored the interactions of biological, psychological or cognitive factors with wider environmental factors.
- This research presents an important evolution from theoretical pathways - such as that posited by Blaszczynski and Nower (2002) – that seek to subtype harmful gambling *after* individuals have already experienced harm.
- The evidence base consisted of 15 individual reviews, themselves a combination of reviews into quantitative data, or mixed data sources (for example, quantitative and qualitative).
- The interaction between biological and environmental factors can heighten the risk of harmful gambling through the availability of gambling, with extant research exploring the effects of different types of gambling products.
- Similarly, the interaction between psychological, cognitive and environmental factors can lead to heightened risk of harmful gambling through the availability of simulated gambling products - online gambling-like activities such as social casino games and video games with gambling content. These do not involve the exchange of money, although some games allow players to purchase virtual credits. These can alter gambling-related cognitions in young people, while engagement with virtual communities can normalise gambling.
- EGM-based products are associated with dissociation, while increased exposure to gambling-related marketing can result in higher recall and intent to gamble.

4.1 Introduction

While biological, psychological and cognitive factors are important in understanding how some individuals may be more at risk of gambling harms than others, they also do not operate in a vacuum and are likely to interact with each other, as well as with an individual's surrounding environment. This is well-established in other areas of study, but we know less about their interaction in relation to gambling harm.

Our scoping review nonetheless found reviews which explored the interaction between the biological, cognitive, and psychological features with wider environmental factors. This important research therefore explores how perceptions and motivations formed by individuals can also be impacted by external factors. These external factors may consist of demographic factors such as socio-economic status, or wider commercial determinants that result in the heightened availability of gambling. Importantly, however, they also represent how the approach to exploring harmful gambling in individuals has evolved since the initial creation of theoretical models that seek to subtype harmful gambling. For example, Blaszczynski and Nower's (2002) pathway model integrates biological, psychological and environmental factors to

subtype individual gamblers. While this model – and subsequent research seeking to develop this model – is important, our scoping review found that there is some evidence that explores how these factors interact *before* subtyping occurs. However, this evidence base is small, highlighting a research gap around the interaction between biological, psychological and environmental factors in relation to harmful gambling.

This chapter begins by introducing the pathway model, and reviews of research that has sought to develop the model. Secondly, the chapter describes the evidence base that emerged from our scoping review around the interaction between biological, psychological and environmental factors. Thirdly, we present the findings of reviews that explored the interaction between biological and environmental factors, followed by those that explored the interaction between cognitive or psychological factors and environmental factors.

4.2 Existing theoretical models

Evidence reviewed within this chapter explores the interaction of the above factors with environmental factors. Models have been developed within previous research which have sought to explore how an individual may be at risk of harms due to specific biological, psychological or genetic factors, in addition to the availability of gambling. For example, Blaszczynski and Nower's (2002) pathways model of 'problem' and 'pathological gambling' integrates biological, psychological and environmental factors into a conceptual framework. The framework argues that those who gamble do so partly because of environmental factors (for example, availability), conditioning, and cognitive processes which result in faulty beliefs related to skill and probability. The three subtypes of 'gambler' are: behaviourally conditioned; emotionally vulnerable; antisocial impulsivist. 'Behaviourally conditioned gamblers' fluctuate between regular or heavy and excessive gambling because of condition, cognitive distortions, and a series of bad judgements or poor decision-making. While they may also use alcohol or show elevated depression or anxiety in response to financial burden from gambling, these are not the cause of their gambling. This subtype is the least severe with the least harm, and they do not show major premorbid psychopathology, substance abuse, impulsivity or antisocial behaviours. 'Emotionally vulnerable gamblers' experience the same environmental determinants, conditioning, cognitive schemas as 'behaviourally conditioned gamblers', but they present with premorbid depression or anxiety, poor coping strategies or problem-solving skills, negative family experiences, developmental variables, and life events. Their gambling is predominantly motivated by a desire to regulate dysphoric mood states or to meet psychological needs, and they will experience elevated psychopathology such as depression, anxiety and alcohol-use disorder. The 'antisocial impulsivist' is the most psychopathological subtype with potential neurological or neurochemical dysfunction, and differentiated from 'emotionally vulnerable gamblers' by features of impulsivity, antisocial personality disorder, and attention deficit. These individuals will report a range of behavioural difficulties independent of

gambling such as excessive alcohol use, substance use, suicidality, irritability, hyposensitivity, and criminality. For these individuals, gambling onset is much younger, reaches very severe levels and is associated with early gambling-related criminal activity.

More recent work has sought to develop the pathway model by exploring the subtypes of gambling. Milosevic and Ledgerwood (2010) reviewed the literature on subtyping 'pathological gambling'. They suggest that the three pathways proposed by Blaszczynski and Nower (2002) reliably emerge from data based on gambling-related motivations. These motivations consist of: relieving or escaping dysphoric moods; marked impulsivity, antisociality, or hyposensitivity; 'normal', 'social', or 'subcultural gamblers' who gamble because of external factors and conditioning, with the absence of psychopathology or maladaptive personality traits. Crucially, however, they note that these subtypes are not necessarily mutually exclusive, and individuals may transition between these intrinsic and extrinsic motivations.

More recently, Kurilla (2021) systematically reviewed the literature to assess the validity of the pathways model of gambling. They noted that the emotionally vulnerable subtype was less valid and more varied than predicted. ADHD, substance use, and childhood maltreatment are likely general risk factors rather than predictive of any single subtype. Generally, subtypes are on the same psychopathologic severity continuum rather than discreet. Social motives appear characteristic of behaviourally conditioned 'gamblers', coping for emotional vulnerability, and enhancement for antisocial impulsivity. In adolescence, there are likely more than three subtypes and a period where there is considerable transition between them (for example, emotional vulnerability to behaviourally conditioned, and antisocial impulsivist to both behaviourally conditioned and emotionally vulnerable). In samples with 'lower severity gamblers', most studies identified more than three subtypes.

Generally, 'behaviourally conditioned gambling' was the lowest severity group, and cognitive distortions were characterized by skill-based cognitions. 'Emotionally vulnerable' and 'antisocial impulsivist gamblers' did not differ on severity in most studies. 'Antisocial impulsivist gamblers' experienced most severe gambling-related cognitive distortions, predominantly related to illusion of control, predictive control and interpretative bias. Emotionally vulnerable gambling was characterised by distorted expectancies and metacognitive beliefs about being unable to control gambling behaviours. High emotional arousal was found to lead to higher gambling severity regardless of impulsivity. Cognitive distortions were more effective at demarcating between subtypes compared to severity of gambling behaviour. For 'antisocial impulsivist gamblers', the most distinguishing trait appeared to be sensation-seeking.

Excell et al. (2022) expanded on Kurilla (2021) to consider other subtyping models of problem gambling, proposing adjustments for subdividing categories or considering biological factors based on personality-related correlates. For example, they argue that comorbid psychopathology and symptom severity should be incorporated into the pathways model. Some papers reviewed by the authors suggested that the antisocial impulsivist

subtype should be removed in favour of a 'biologically vulnerable' subtype, while others suggested that it should be removed altogether. Several papers suggested changes to the behaviourally conditioned subtype. Suggestions for other models included being based on symptom severity (for example, low, moderate, or high), by frequency of play, or by psychopathological comorbidity (for example, mood disorders or substance-use disorders). Others include motivations for gambling and preferred games.

This research demonstrates that work has been carried out to explore the theoretical modelling of individuals at risk of gambling harms. However, the pathway model is used to subtype individuals who are *already experiencing* harm. They also focus on individual factors as their initial purpose was to inform individual treatment approaches. There is a need to specifically explore how individual factors interact with environmental factors to initiate harmful gambling *before* subtyping occurs. The remaining literature in this chapter therefore represents how the research on gambling has evolved from a theoretical approach to helping individuals, to exploring how their interaction with external environments can lead to harmful gambling in the first instance.

4.3 About the evidence base

The sample size that informed this chapter was smaller than that of the previous chapters, formed by 15 reviews. The methodologies that informed the reviews were also more varied, containing quantitative studies (King and Delfabbro, 2016; Merkouris et al., 2016; Dowling et al., 2017; Calado et al., 2017; Allami et al., 2021), and mixed methodological studies (Delfabbro et al., 2012; Vasiliadis et al., 2013; Guillou Landreat et al., 2019; Bouguettaya et al., 2020; Frisone et al., 2020; Labrador et al., 2021; Riley et al., 2021; Rogier et al., 2021b). The sample sizes ranged where specified from 17 individual studies (Dowling et al., 2017) to 107 individual studies (Frisone et al., 2020). As with the previous chapters, sample sets across the reviews included a range of gambling severities, and ages.

4.4 Interaction between biological and environmental factors

Firstly, as part of the examples uncovered during the scoping review, we highlight examples of reviews that explored how the biological factors have interacted with wider environmental factors to result in the risk of harmful gambling for individuals. Specifically, we explore how wider socio-demographic factors interact with neuropsychological factors, before exploring how biological factors can also interact with wider commercial and social determinants.

4.4.1 Wider socio-demographic factors can interact with neuropsychological factors

Dowling et al. (2017) performed a meta-analysis of longitudinal data examining risk and protective factors related to 'problem gambling'. Overall, they found 15 thematic risk factors and three protective factors with a sufficient evidence base to posit a longitudinal association with 'problem gambling'. In relation to the early risk factors:

> "These included 13 individual factors (alcohol use frequency, antisocial behaviours, depression, male gender, cannabis use, illicit drug use, impulsivity, number of gambling activities, problem gambling severity, sensation seeking, tobacco use, violence, uncontrolled temperament), one relationship factor (peer antisocial behaviours), and one community factor (poor academic performance). No early risk factors for the development of problem gambling classified in the societal level of the socio-ecological model were identified in the review" (Dowling et al., 2017, p. 119).

The associations had small to medium effect sizes and many factors remained robust in multivariate analyses, thus suggesting an adequate degree of independence from each other. The strongest socio-demographic risk factor was male gender. Other strong risk factors included early gambling severity and number of gambling activities played. In terms of alcohol and substance uses, behavioural theories such as cross-substance coping response hypothesis are popular where negative reinforcement may promote simultaneous use as self-regulation strategy, where each activity alleviates the adverse effects of the other. Alternatively, the compounded positive reinforcement of using both activities, or the cross-substance cue-reactivity model where repeated pairings result in cross-conditioning, or finally the attention allocation model where substances impair the ability to process information and restrict attention to most salient internal and environmental factors. Other important factors but with small effect sizes were antisocial behaviour (delinquency and theft), violence, peer antisocial behaviour, and a medium effect size for poor academic performance. This was particularly the case for males. In terms of the personality-related factors, findings suggested that a tendency to be impatient, overactive, impulsive and easily distracted, with an inability to foresee negative consequences and to stop responding despite unfavourable outcomes puts youth at high risk for developing 'problem gambling'.

There were also important non-significant findings in relation to anxiety symptoms, psychological distress, negative affect and suicide ideation and their relationship to 'problem gambling'. This suggests that the associations seen in the cross-sectional literature are not replicated in the longitudinal work on young people. This indicates that they may coexist because harmful gambling leads to internalising symptoms, or that they share common causes, not that internalising symptoms lead to 'problem gambling'. As for protective factors, only three significant findings were identified which all had small effect

sizes: parental supervision, socio-economic status, and social problems. Even then, the findings for parental supervision and socio-economic status were mixed, which reflects the cross-sectional adolescent literature. Socially, the authors found that individuals who get along with their peers are at higher risk of gambling problematically.

4.4.2 Biological factors that influence gambling behaviours can interact with wider commercial and social determinants

Calado et al. (2017) explored the prevalence of gambling amongst adolescents, and factors that are associated with 'problem gambling'. The authors found that 'problem gambling' in Europe was more likely amongst males, members of ethnic minority groups, those whose parents gambled, those who did not live with both parents, and older adolescents. 'Problem gamblers' were also more likely to gamble on the Internet given the lack of verification required alongside the lack of parental supervision. The most frequent motivations were to escape and an inability to resist temptation. Winning money was mentioned less by 'problem gambling' than 'non-problem gambling' adolescents. Other significant predictors included an experience of winning a large amount of money early in playing careers, and lower socio-economic status. There was also a clear link between gambling and substance use, although the motivations for these may vary. The most popular youth gambling activities included lotteries, scratch cards, card games and slot machines. 'Problem gamblers' played more games than 'non-problem gamblers'. The most addictive products appeared to contain high-event frequencies, immediate outcomes, and short interval structures like slot machines. These were also highly accessible. 'Problem gambling' rates were higher in adolescents than adults, likely because of its association with risky behaviours, but also because of reduced responsibilities carried by adolescents. Gambling was also found to be heavily promoted and normalised.

Guillou Landreat et al. (2019) reviewed the determinants of gambling disorder in older populations and found specific preferences for types of gambling products. Individuals aged over 65 accounted for around 40% of casino users. They highlighted how 'problem gamblers' aged 55 and over tended to play slot machines and continuous games – including online games and scratchcard-based products - whereas those without gambling disorder tended to play discontinuous inexpensive and time-limited games like lotteries. However, there was limited evidence that explored the specific, structural features of gambling products that appealed to the elderly. Eighty percent of older participants across the evidence reviewed by the authors gambled for entertainment and enjoyment. Thirty-eight percent gambled to distract themselves from problems and to combat boredom and loneliness. Older women over 75 appeared particularly vulnerable to offers (such as the use of

bus tours), marketing strategies, and the use of EGMs. Women over 60 contained a risk factor that was equal or higher than men of the same age (25% in some studies). Although, generally, 'problem gamblers' were younger than 'non-problem gamblers'. Comorbidities that were identified amongst participants who gambled within the authors' review included tobacco and alcohol use, general health impairments, anxiety disorders, avoidant personality disorder and cognitive impairments. They also uncovered associations with Parkinson's disease and associated dopaminergic medication.

Allami et al. (2021) performed a meta-analysis on risk factors for 'problem gambling' and ranked them in order of effect size. They found that the strongest predictors were online gambling, EGM and slot machines (non-casino), EGM and slot machines (casino), and playing poker. Continuous forms of gambling (high rate of play, short interval, speedy outcomes) were therefore outlined as the riskiest forms of gambling. All socio-demographic factors had small effect sizes on gambling behaviour (ethnicity, age, gender, marital status, education), while some had no relationship at all (income, military status, urban areas, employment status, having children, religiosity). The authors' analysis of subgroups found that men and young people were the most vulnerable groups. In terms of psycho-social factors, those with mental health problems display higher problem gambling compared to physical health conditions, especially attempted suicide, suicidal ideation, anxiety, internalizing symptoms, depression, any mental health problem. In terms of social factors, filing for bankruptcy showed a small effect size, while playing sports showed a medium effect size. Moderate effects sizes were seen for most substances including substance related problems, cocaine, illicit drugs, daily tobacco, binge drinking, marijuana. Interestingly, alcohol use was not related.

Riley et al. (2021) reviewed the risk and protective factors associated with gambling in young people and adolescents. They found hugely variable prevalence rates for lifetime and past-year gambling, which may be due to a lack of consistent definition or understanding of what constitutes gambling. The prevalence of 'problem gambling' varied between 3.6% and 5.6%. Young males experienced greater levels of participation and problems than females, and were therefore up to between 25 and 37 times more likely to develop gambling problems. Attaining low levels of education and having fathers with low education made older males more vulnerable. Sports involvement increased gambling behaviour, but was only associated with increased 'problem gambling' for males. Males were also more affected by parental attitudes to gambling. Males were more likely to gamble frequently, but it was frequent gambling generally – not male frequent gamblers – that resulted in the highest likelihood of developing gambling problems. There was a high prevalence of alcohol and substance use, and involvement with violence, amongst 'problem gamblers'. There was also some evidence that 'lower-risk problem gamblers' were at more risk of harmful alcohol or substance use. There was a consensus that sensation-seeking was a significant predictor. Multiple social connectedness factors were related to 'problem gambling' such as parental attachment (mediated by alexithymia), poor school relationship,

and lower family connectedness. The risk of harmful gambling increased with age. Hyperactivity, conduct problems, emotional and attentional problems, delinquent behaviour, social dysfunction, higher family incomes, and childhood exposure to tobacco were also all related to adolescent 'problem' gambling. Regarding other risk factors, higher family incomes were associated with adolescent and youth gambling, along with childhood exposure to tobacco.

Furthermore, increased proximity to venues and gambling on games with 'perceived skill' were also important predictors. The associations between online gambling and adolescent 'problem gambling', and social casinos and adolescent 'problem gambling' were mixed. The vast majority (over two-thirds) of adolescents deemed gambling to be risky, but also believed that gambling returned a good yield on investment. The two main reasons to gamble were to make money and to regulate emotions. In countries with low socio-economic status, gambling was seen as a way to escape poverty. 'Problem gambling' was more likely to be associated with motives to win money, or to increase positive emotions compared to non-risky gambling. Participants experiencing 'problem gambling' also tended to have higher scores on emotion dysregulation and maladaptive coping.

4.5 Interaction between psychological, cognitive, and environmental factors

We also found reviews that focused on extant research exploring the interaction between an individual's cognitive or psychological traits (such as behaviour or gambling-related beliefs) and their wider environment. As this section explores, this may reflect the behaviours that emerge as a result of the interaction of cognitive traits with gambling products, or the alteration of an individual's cognition which can occur due to exposure to gambling-related stimuli (such as marketing), or their interaction with specific products.

4.5.1 Harmful, in-person gambling can be associated with specific behavioural factors

Delfabbro et al. (2012) reviewed the behavioural indicators related to 'problem gambling'. They analysed a table of indicators associated with 'problem gambling' behaviour: physiology (for example, nausea, perspiration, headaches, dry eyes); frequency, duration and intensity (length of session; frequency of sessions per week; time spent gambling; use of two machines at one time; stake size; reservation of machines; excessively high focus; not eating; difficulty stopping; waiting for entry); betting patterns (riskier bets; increasing bets; reinvesting wins; bets placed late in roulette spins; loss chasing; frequency increasing over time); social behaviours (avoidance of social contact; rudeness to staff; deceptive behaviour); fundraising (withdrawing more cash; attempts to use cheques or credit cards; frequent

cash out; sale of possessions); emotional reactions (anger; crying from losses; shaking; edginess and nervousness; striking machines; swearing at machines or staff; blaming venue); appearance (lack of care); and concurrent activities (smoking or drinking heavily). While there was some support for these indicators especially when considered in combination, reviewed studies were conducted in heterogeneous samples. Across various studies, participants experiencing 'problem gambling' demonstrated: feelings of nausea whilst gambling; using credit cards; shaking; getting cash frequently; being more socially withdrawn, angry, anxious depressed; being more immersed; rapid speeds-of play; trying hard to win on one machine; inability to stop; and strong emotional responses. On the other hand, 'non-problem gamblers' rarely felt emotionally attached or the need to disguise gambling. In terms of technological indicators, 'problem gamblers' often wagered more often, placed larger bets, and engaged in more intense betting soon after enrolment, but chose less risky odds prior to closing their accounts.

4.5.2 Simulated gambling can alter gambling-related cognitions in young people

King and Delfabbro (2016) reviewed literature on simulated gambling exposure in young people (defined by the authors as aged between 0 and 18 years although the youngest age in the sample of literature was 12) and proposed a conceptual model for understanding how simulated gambling may relate to the experience of gambling addiction. The authors adopted King et al.'s (2014) definition of simulated gambling, as a "digitally simulated interactive gambling activity that does not directly involve monetary gain but is otherwise structurally identical to the standard format of a gambling activity due to its wagering features and chance-determined outcomes of play" (King et al., 2014, p. 305). They acknowledged that research was overwhelmingly focused on risk factors, and no study had attempted to quantify how young people may develop adaptive, safe or healthy perceptions of gambling based on simulated gambling. The two strongest risk factors of simulated gambling on a player's understanding of gambling related to chance-based properties and profitability. Simulated gambling is riskier when the activity is part of a subculture with avenues to financial gambling, where there is an active network of peers and experienced gamblers providing incentives (prowess, recognition), a parental authority that models unhealthy behaviour, or when it is engaged with covertly and excessively (no responsible supervision). Structurally, websites make harm more likely if they embed links directly to, or promote, financial gambling opportunities, integrate with social media and video streaming platforms, are highly accessible from portable devices, and have the capacity for remote and anonymous play. Behaviourally, risk factors included early 'big wins', virtual currencies and easy migration to real money games, when play becomes intense, persistent and escalating. These behavioural factors were supported by structural factors such as non-random win-loss distributions, 'freemium' economy features such as micro-transactions and 'pay-to-win' options, unrestricted stake sizes and purchase limits and frequent bonus credits. The cognitive risk factors included

misinterpretation of chance and probability, undervaluation or miscomprehension of in-game currency, and the false belief of gambling as based on skill or strategy. The structural elements that made harm more likely included misleading payout rates that built overconfidence in winning, an obscure economy system with 'soft' and 'hard' currencies of volatile contextual value depending on player progression and level, and the activity being marketed as a 'game' without acknowledging gambling features. Emotionally, players who experienced gambling addiction were likely to report higher levels of excitement, arousal, lower loss sensitivity, being motivated by relieving dysphoric mood, and strong urges to gamble real money.

The authors also mirrored risk factors with protective factors which can also be informative about what might lead to harmful gambling. For example, simulated games could remove the mystery and allure of a 'forbidden' age-restricted activity, if they are supervised by an adult, or if it provides opportunities for education and feedback. Structural features to support this could provide accurate analogues to adult activities which lack aesthetic youth enticing features, integrate with parental accounts, and are accompanied by promotion messaging that reinforces realistic and factual knowledge of the game. In terms of behavioural domain, protective factors could include players experiencing normal win-loss outcomes or early-losses, having no financial elements thus removing loss-chasing, having the activity framed as an education experience that provides information about gambling odds and winning. Possible structural designs to support protective factors include realistic payout rates that do not overinflate wins at early stages of play, an inability to purchase items or virtual currencies, the provision of informative fact-based messaging about how gambling works, the minimisation of extrinsic feedback and incentive messaging, and restrictive stake sizes and purchase limits or credits that can be saved or used across sessions.

In relation to cognition, simulated gambling could be protective as players could develop awareness of gambling risks, thus improving understandings of the time and monetary costs of gambling, the basics of probability and chance, in addition to the players' critical thinking of wider issues such as industry motivations and player vulnerabilities. Structural features that support these could include realistic analogue features, player feedback features, youth-appropriate odds information and education on 'luck' and 'skill', as well as resources that focus on 'responsible gambling' and problem gambling awareness. In terms of emotional features, players who experience boredom, lack of interest or greater loss sensitivity, or diminished urges to use real money are least at-risk.

4.5.3 Engaging with virtual communities can normalise gambling behaviour

Sirola et al. (2021) reviewed the literature on virtual communities and gambling behaviour and found that identifying with online communities can influence gambling behaviour. Online communities existed around gambling discussions such as sharing tips, strategies and experiences. In-game

communities were accessible through chat options in online poker games, as well as online social casino games. Participating in online communities that have a positive attitude to gambling is an important risk factor for problematic gambling, although some evidence suggests this could be moderated by loneliness. Participants across the sample who gambled due to loneliness were most likely to take part in these online communities. Poker-based communities also reinforced successes and sharing experiences and lead to development of cognitive biases. However, some longitudinal data suggested that online poker players spent less money when they were more active in their virtual community. In another study reviewed by the authors, active community members spent less money as their community involvement increased, but non-active members' spending increased in-line with community engagement.

Furthermore, socialising with others during play was associated with less problematic forms of gambling. Gambling issues were generally more severe amongst participants who were experiencing loneliness, who stayed clear of social interaction tools and who preferred to gamble against the computer. Thus, utilising poker communities in and outside the game can protect from excessive poker gambling habits. In non-poker forms of gambling, likes and invites to play, as well as the perceived number of users or friends playing social casino games was found to influence intentions to play and jackpot or purchase intentions. Additionally, sports bettors were found to be sharing wagers, results, opinions and tips with others and celebrating wins, thus normalising the behaviour. Problem-focused communities helped people to cope and even overcome problems through sharing experiences and harm minimization strategies. Participants gambling online were more likely to access these online forums than land-based bettors. Females were less likely to use in-game social tools, perhaps because of the male dominance in these spaces. Females did however use anonymous online forums, especially if intimidated by the idea of face-to-face, male-dominated therapeutic environments. Finally, as these communities were grounded in mutual norms and acceptance is based on conformity to be a legitimate community member, they were spaces where identities can be formed and constructed, and even reconstructed in the case of ‘problem gamblers’.

4.5.4 Increased exposure to marketing can result in increased recall and intent to gamble

Bouguettaya et al. (2020) performed a meta-analysis to understand how advertising relates to gambling attitudes, intentions and behaviour. The authors highlighted the need for caution in interpreting their findings due to the methodological and statistical shortcomings of the research they reviewed. The evidence base was also less developed compared to other harmful products, such as alcohol and tobacco. Nevertheless, the limited evidence available suggested a moderate link between advertising and increased

positive attitudes, and a weak link between advertising and greater intentions to gamble (although, there is a lack of evidence to demonstrate a link between intention and behaviour). There was a small relationship between exposure to marketing and gambling behaviour. Additionally, greater exposure is associated with greater problem gambling but the directionality here is unknown. There was some evidence of a dose-response effect with greater exposure relating to increasing favourable opinions towards gambling. Also, a dose-response effect was also found in behaviour where more scratch-card advertising led to greater purchasing of scratch-cards. Qualitatively, gamblers perceived advertising as normalising the behaviour and providing incentives, while targeted directed messaging resulted in heightened intentions to gamble. Cross-jurisdiction impacts of the availability to gamble were also found, with the removal of marketing restrictions in Macau leading to increased marketing and subsequent gambling behaviour in Hong Kong.

Labrador et al. (2021) examined the past decade of gambling advertising literature and reviewed its effects on youth and adolescent people who are regularly exposed to gambling advertising. Most participants across the evidence reviewed by the authors were critical and felt the adverts were trying to trick them into gambling, and deceived them with tactics like exaggeration. A third of adverts were found to be ignored, not understood or rejected. Many felt advertising would not impact their behaviour. Between 10% and 15% saw themselves betting before the legal age, while those with gambling problems felt that the adverts make them want to bet. The recall of adverts can predict gambling behaviour in young people and predict the change from simulated bets to real money. Most youth and adolescent people (96.4%) received advertising on multimedia platforms, but they also appeared ubiquitously on the Internet through media such as pop-ups, social media, websites, on sporting kits, and influencer videos. Adverts that impacted the youth and adolescents most were visually appealing, offered free money, suggested some control over the game, framed gambling as a test of skill, contained some sort of simulated game-like content, or contained famous sports athletes or other celebrities.

4.5.5 EGM-based products are associated with dissociation

Our review also uncovered research that displayed an overlap with findings emerging from our scoping review carried out as part of Challenge 4, specifically on how the design of gambling products may lead to the experience of immersion (Wheaton et al., 2024b). Rogier et al. (2021b) conducted a qualitative synthesis and meta-analysis into the relationship between dissociation and problem gambling. Importantly, the authors noted that dissociation is more akin to being ‘zoned-in’ than it is to being ‘zoned-out’. They found a moderate relationship between dissociation and gambling disorder, supported by almost all studies, which did not appear to be moderated by other factors. Those with gambling disorder were more likely to experience a range of dissociative states such as trance, feeling outside

oneself, memory blackouts, feeling like a different person. They also suggested that dissociation could lead to an inability to control time and money spent. Alternatively, gambling itself could be seen as a dissociative behaviour, with people using gambling to dissociate from negative feelings and stresses. For instance, depression was not sufficient on its own to lead to 'problem gambling', however, if the person also uses distancing and denial coping strategies then this could lead to 'problem gambling', while dissociative states act as a form of escape-avoidance mechanism. Although, there is little agreement on the relationship across literature. The authors cite EGMs as the most capable gambling products of producing dissociative-like states due to their audial and visual features. Video lottery machines can also produce dissociative experiences in people with little history of dissociative states, and can lead to loss of time, lack of awareness of sights and sounds and interactions. Moreover, multiline slot machines contain high win frequencies and easily induce 'dark flow' - a trance like state that is immensely pleasurable, allowing players to escape negative thoughts and emotions. Proneness to experience altered states of awareness was related to absorption of attentive resources, thus leading players to shut themselves off to external thoughts or interferences. Overall, dissociation could be a determinant, a maintainer, a game-specific feature, a coping strategy.

4.5.6 Heightened accessibility is associated with increased gambling

Reviews within our scoping review also explored research into the impact of the heightened availability to gamble. For example, LaPlante et al. (2019) reviewed literature on the expansion of the availability of gambling and changes in gambling-related outcomes among the population. They found that 64.7% of post-expansion outcomes reported no change or a decrease in gambling, whilst the remaining 35.3% reported an increase.

Vasiliadis et al. (2013) reviewed the literature on the effect of physical accessibility of gambling opportunities on involvement and gambling rates. They found that the relationship between proximity and density of physical accessibility and gambling is complex. The research suggested a positive relationship between proximity to gaming venues and increases in expenditure and participation, but only little evidence that this was associated with increased 'problem gambling'. Moreover, where only casino-style destinations are available, proximity and density related to involvement and 'problem gambling'. However, where the opportunity to gamble was more widely spread out, the proximity and density of gambling opportunities were associated with greater involvement in gambling, but proximity alone was strongly associated with rates of 'problem gambling'. This suggests that those experiencing 'problem gambling' are more likely to be harmed when gambling opportunities are in a greater number of locations. Also, diffuse opportunities were more strongly related to involvement and 'problem gambling' than when only casinos were available. The authors argue that gambling involvement is a function of market growth, with communities adapting to the introduction of

new venues. However, those experiencing ‘problem gambling’ increase their gambling with greater exposure. The authors also found that gambling appeared to be specifically related to lower socio-economic status.

4.6 There is mixed evidence around the role of gender

Finally, the scoping review explored research around the relationship between gender, psychological factors, and wider environmental contexts. Merkouris et al.’s review of 29 papers (2016) found that females experiencing ‘problem gambling’ were more likely to have experienced greater psychological distress, experienced childhood abuse, and be unemployed. Males experiencing ‘problem gambling’ were more likely to experience greater impulsivity, as well as report higher rates of substance and alcohol use. In relation to game preference, females preferred non-strategic gambling such as EGMs and bingo, whereas men preferred strategic games such as sports betting and casino games. The authors, however, found that the majority of findings were mixed or limited by the small number of studies. Therefore, although males were consistently shown to be at higher risk, the authors argued that gender may play an indirect role that lies amongst other demographic, economic, and health-related factors. Nonetheless, the authors concluded by arguing that EGMs remain the primary source of problems for males and females.

Frisone et al. (2020) performed a narrative review of adolescent gambling research from the past 20 years. Regarding gender differences, most participants experiencing ‘pathological gambling’ were males. Males were also more likely to use illicit substances. Indeed, drug usage was also associated with ‘pathological gambling’. Additionally, adolescents who gambled were more likely to experience poorer impulsivity. The authors also highlighted that wider societal factors were not considered within the literature.

4.7 Conclusion

This chapter has uncovered literature that highlights the association between harmful gambling, biological factors and environmental factors, as well as the increased exposure to gambling-related stimuli and associations with altered cognitions. While again the findings are based on mainly cross-sectional data, the evidence highlights how increased exposure to gambling may impact the motivation to gamble, particularly amongst individuals who present specific neurobiological or cognitive factors. This evidence highlights how the factors highlighted within the previous chapters are likely to interact with each other, and highlights how those at risk of gambling harms can be protected from the heightened availability of the sector.

5 Summary and conclusions

Our report has outlined the findings of a scoping review which sought to answer the question, “what initiates harmful gambling?”. Specifically, the scoping review explores how individual perceptions, individual intrinsic and extrinsic motivations, and decision-making processes differ to leave some individuals at more risk of the initiation of gambling harms than others. The scoping review uncovered evidence which can be grouped according to three key themes.

Firstly, gambling-related perceptions and motivations can be influenced by biological factors. These biological factors consist of genetic factors that play an important role in future gambling-related outcomes, in addition to the comorbidity of harmful gambling and neuropsychological differences. For example, individuals living with ADHD or OCD are more likely to experience harmful gambling, while harmful gambling in Parkinson’s disease is associated with forms of dopaminergic treatment. Neuroscientific research also highlights that harmful gambling is associated with increased reward-seeking, increased dopamine release, and can be associated with reduced cognitive control.

Secondly, our scoping review found that harmful gambling can be associated with psychological and cognitive factors. For example, alexithymia is associated with an increased risk of gambling-related problems, while harmful gambling can be associated with certain personality traits, particularly neuroticism. People who gamble are also likely to experience greater arousal from gambling-related stimuli. In relation to cognition, stress can both contribute to, and be caused by, harmful gambling, while harmful gambling is associated with high impulsivity, low inhibition, and compulsivity. Cognitive distortions are associated with harmful gambling, while heavier gambling can be associated with reduced perceptions of risk. Age can also be a factor that interacts with gambling-related motivations, with gambling now perceived as normal for young people, while older adults are motivated to gamble for a variety of reasons, including to socialise, to take part in exciting activities, and to enjoy other aspects such as accompanying food or holidays.

Limited work, in comparison, has explored how these factors interact with each other and with external environmental factors. While existing models – such as the pathway model (Blaszczynski and Nower, 2002) – may develop a subtype of gamblers and model their interaction with their environment, they only do so once gambling harm is already being experienced. As gambling-related research has evolved, a greater emphasis on understanding how the biological, psychological and genetic factors are likely to interact with environmental factors will not only benefit the individual, but also provide better awareness on how to first protect individuals from gambling harms in the first instance. The interaction between biological or psychological factors and environmental factors that lead to greater risk of harmful gambling can include wider socio-demographic factors such as education or socio-economic status, but also environmental factors that normalise gambling such as the heightened availability of gambling, or participation in online communities.

There are limitations to be considered alongside these findings. Little work has sought to understand how individuals move in-between periods of high and lower risk, especially when they are not classified as ‘treatment seeking’. We

also know little about the reinitiation of harms should an individual experience relapse. Additionally, our scoping review of reviews means that any literature covering themes where no reviews have taken place may also have been missed. Nonetheless, this scoping review still highlights the need for further exploration of how psychological, biological, or cognitive factors interact with environmental factors to leave individuals at heightened risk of harmful gambling.

Our scoping review also uncovered a lack of longitudinal data. Dowling et al.'s (2017) longitudinal study is an important example that synthesises the existing research on the crucial period of development from adolescence to early adulthood. However, no longitudinal work has been conducted in the past six years in this area and an update is required. Finally, research in this area could gather a deeper understanding of gambling harms by moving beyond standardised screening tools such as PGSI or SOGS, to explore the complex nature of harms that can emerge from the combination of factors explored above.

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Appendix One: Search terms and databases

The initial search for literature within this scoping review was guided by the overarching research question: “What initiates harmful gambling?”. The search terms and databases were formulated with guidance from University of Bristol academics involved in the Bristol Hub for Gambling Harms Research with expertise in psychology and neuroscience research.

The search terms were: (gambl* AND (bio* OR psycho* OR social* OR harm* OR perception* OR motivation* OR decision* OR risk* OR (game AND design) OR subtypes OR pathway* OR neur* OR gene* OR dopamine*)).

These search terms were entered into the following databases:

- Web of Science,
- PsycINFO
- Scopus
- Ovid Medline
- International Bibliography of the Social Sciences

Appendix Two: Review inclusion and data abstraction

To be included, reviews were required to be in format of a review, published after 2005, in English, focusing on economies with a similar economic outlook to the United Kingdom, and be specifically linked to the research question. Reviews therefore needed to specifically related to the initiation of harmful gambling. Table A1 below details the numbers of included and excluded reviews, as well as the reasons for exclusion. Papers, after de-duplication, were sifted by title, abstract, and then by full text.

Data were then abstracted from included texts, with specific criteria. These criteria are introduced in Table A2. Data abstracted under these criteria were subjected to narrative analysis, with the most prevalent themes within the data answering the guiding research question. Themes mainly emerged from data gathered under the ‘Summary of Findings’ criteria, but these data were developed in conjunction with other data highlighted within other fields.

Table A1: Details of included and excluded reviews

Sift One: By Title	Sift Two: Additional Review Sift by Title	Sift Two: By Abstract	Full Text: Data Abstract
Titles Sifted: 18,506	Review Titles Sifted: 313	Abstracts Sifted: 161	Reviews Screened: 112
Reviews Included: 313	Titles Included: 161	Abstracts Included: 112	Reviews Included: 87
Titles Excluded: 18,193	Titles Excluded: 152	Abstracts Excluded: 49 *Reasons for Exclusion:*	Texts Excluded: 25 *Reasons for Exclusion:*
Titles excluded due to not being a review, or not being clearly related to the research question.	Reviews excluded due to not focusing on the initiation of harmful gambling	Not related to research question: 15	Reviews excluded due to not focusing on the initiation of harmful gambling
		Published before 2005: 7	
		Non-review format: 21	
		No full text: 2	
		Non-human participants: 3	
		Contained in more recent umbrella review: 1	

Table A2: Criteria of data abstraction

Authors	The names of the authors of the review.
Year	The year in which the review was published.
Abstract	The abstract of the review.
Title	The title of the review.
URL	The URL or online link through which the review was found.
Meta-Analysis	Whether the review contained a meta-analysis of previous quantitative data.
Subtopic	The subtopic found within each review.
Aim or Research Question	The guiding research question or focus of each review.
Population	The main characteristic of participants under focus within the review. This may have depended on age (for example, inclusion of adults), or by severity of gambling behaviour.
Country	The jurisdiction under focus in each review.
Study Types	The type of study included within each review (for example, qualitative, quantitative or mixed-methods).
Funding and/or Conflict of Interest	The funder of each paper, if given, and the declaration of any conflicts of interest, if given by the authors.
Summary	A summary of the findings produced within each review, in addition to conclusions reached by the authors as a result of the data they have reviewed. Summaries may also include implications highlighted by the authors for future studies or interventions.
Limitations	Limitations outlined by the authors of each review.

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