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How cognitive bias prevents serendipity in new product development (and what to do about it)

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Abstract

The purpose of this paper is to identify practical strategies that New Product Development (NPD) managers can undertake to increase the likelihood of serendipity within the NPD process, by focusing on overcoming the barriers presented by cognitive bias. We adopt an alternative methodological approach based upon analogical reasoning to develop a series of propositions that explain the relationship between cognitive biases and serendipity. We present a process model of how serendipity unfolds within NPD. We provide a detailed analysis of cognitive bias within NPD, and identify those categories of biases which are most likely to hinder the occurrence and realisation of serendipity in NPD. Finally, we propose a strategy of debiasing NPD activities to enable serendipity and thereby improve new product performance. The paper concludes with a research agenda and discusses implications for firms.

Keywords: Cognitive bias; Debiasing; Serendipity; New Product Development.

1. Introduction

Innovation is a survival imperative in a rapidly evolving technological landscape, but the management of innovation is subject to a variety of conflicting forces (Andriopoulos and Lewis 2010). Managers must be seen to deliver valuable and relevant work that meets their predictions and targets. They must also deliver new products and services that are novel, and much better than the current generation. These aims whilst understandable are in direct conflict. Novel outcomes require flexibility and exploration, and novel projects have a high risk of failure (D'Este et al., 2016), which should be embraced (Luchs et al., 2016; Baxter et al., 2023). 'Flexibly embracing failure' cannot comfortably co-exist with a predictable, low risk, reliable product development process. This tension is particularly acute in the pursuit of radical innovation, which offers "unprecedented performance benefits" (Slater et al., 2014), but also the highest levels of uncertainty (Brentani and Reid, 2012).

This conflict, and the fact that we still try to pursue both certainty and novelty, can be explained in terms of cognitive bias. In making decisions we systematically violate rationality (Tversky and Kahneman, 1981), and still make these errors even when we are fully aware of the cognitive biases causing the irrational decisions (Kahneman and Tversky, 1977). Cognitive bias is highly relevant in the management of new product development (NPD), because novel situations require a lot of uncertain choices (Potts 2010). Behaviour in NPD projects does not align with the expectations of rational choice (Dosi and Lovallo 1995; Solan and Shtub, 2019). Cognitive biases that work against rational choices in NPD projects include, amongst others, loss aversion (Tversky and Kahneman, 1991), or the status quo bias (Godefroid et al., 2022), the endowment effect, availability bias, and risk aversion (e.g. Liedtka 2015; Potts 2010). Because of these biases, we overvalue what we already have, we make biased choices against loss and towards certain outcomes, and we are bad at correctly

assigning the value of novel information. Thus, the presence of these biases leads to an NPD process in which we continue to irrationally prefer a low-risk approach, which is unlikely to deliver the radically better outcomes that competitive strategies require.

Serendipity, the notion of making surprising and valuable discoveries that lead to valuable outcomes (Busch, 2022), is likely to be a contributor to radical NPD (Andriani et al., 2017; Andriani and Kaminska, 2021; Wijngaarden et al., 2021). Within public discourse, serendipity is commonly used as a synonym for luck or good fortune. This is understandable because it delivers outcomes that are unforeseen and unplanned (Rauch and Ansari, 2021). Yet a more careful examination shows that serendipity should be viewed as the result of purposeful actions (De Rond, 2014; Garud et al., 2011 Wareham et al., 2022). This has led to a significant amount of theoretical development in recent years (Yaqub, 2018, Busch, 2022), including some studies investigating whether serendipity can be engineered (Lane et al., 2021). In the first systematic literature review on serendipity in management studies, Balzano (2022) draws attention to the lack of empirical studies of the concept, attributing the difficulty of operationalising 'serendipity' for quantitative research. In this paper we follow his recommendation (Balzano, 2022, p143) and adopt an alternative methodological approach based upon analogical reasoning (Ketokivi et al., 2017, Cornelissen, 2017) in order to develop a series of propositions that explicate the relationship between cognitive biases and serendipity, and thereby offer practical implications for NPD managers who would like to maximise the potential offered by serendipitous events. Thus, our research question is: How does cognitive bias affect the process of serendipity within NPD?

In this paper, and following Balzano (2022), we examine the theories and contexts of serendipity across different fields of study and mobilise this knowledge in the domain of

new product development. Specifically, we draw upon the theoretical development of serendipity and innovation in culture studies (DeRond, 2014), science studies (Yaqub, 2018) and Organizational Studies (Busch, 2022). Significantly, while there is a considerable body of literature identifying factors and activities that can enhance serendipity occurrence (Balzano, 2022; Busch, 2022; Andriani et al., 2017; Andriani and Kaminska, 2021; Wijngaarden et al., 2021; Rauch and Ansari, 2021) there is scant literature identifying those issues that hinder the occurrence of serendipity within NPD. We argue that such hindrance operates in two guises. Firstly, cognitive biases constrain the practical actions of NPD teams and hinder the occurrence of chance events. Secondly, cognitive bias hinders the recognition of new value in these chance events when they do occur. This is because for serendipity to be realised a series of activities need to occur. Cognitive bias prevents both the noticing of an unexpected event and then the necessary novel associations from being made. This line of reasoning leads us to suggest a strategy for enabling serendipity (and thereby improving NPD performance) by conscious attempts at de-biasing NPD activities (Marzi, 2022; Balzano and Marzi, 2023). Thus, the motivation of this study is to identify practical activities that NPD managers can undertake to increase the likelihood of serendipity within the NPD process. Our research contributes to the debate on how to manage serendipity within the NPD process (Yaqub, 2018, Busch, 2022), and challenges the notion that increasing the likelihood of unexpected occurrences will lead to serendipity (Lane et al., 2021). We emphasise that debiasing the NPD task can enhance serendipity outcomes.

Section 2 examines how serendipity unfolds in organisations; we also explain our research approach to developing a theory of serendipity in NPD. Section 3 provides a summary of the main cognitive biases influencing NPD and develops a series of propositions illustrating how

these biases influence the process of serendipity. We also provide five separate vignettes. Section 4 presents a proposal to enhance serendipity in NPD through de-biasing. We conclude with a discussion of our main findings including implications for firms and considerations for future research.

2. Conceptualising Serendipity and how it Unfolds in Organisations

Originally written in the 1950s, the publication of Merton and Barber's (2004) book 'The Travels and Adventures of Serendipity' prompted a renewed interest in scholarship focusing on serendipity (e.g. Cunha et al., 2010, Murayama et al., 2015). Robert Merton's research into serendipity began in the 1940s and over a period of several decades led him to chart its lexicographical history. In a later theoretical analysis of the concept, Yaqub (2018) takes Merton's extensive notes as a starting point and shows that serendipity can arise in different forms and in a variety of ways. Yaqub's aim is to clarify the meaning of the term 'serendipity' by drawing attention to the heterogeneity of the phenomenon. Having thematically analysed Robert Merton's extensive archive he elucidates a 2x2 typology comprising four ideal types of serendipity (Yaqub, 2018). Writing in a different disciplinary area De Rond (2014) also derived a logically identical 2x2 typology, conceptualising serendipity as something which springs from the noticing of pairs of events that are meaningfully related. Rather than focussing on the event itself, he characterises serendipity as a capability of 'combinatorial play', that involves recombining disparate observations and inferring a meaningful relation that can be put to some use. On this basis De Rond argues that the concept of serendipity is essential for a complete understanding of innovation, though the case material is concerned with scientific discovery.

Where these typologies draw attention to serendipity as an outcome, other threads of research adopt a processual view. Through his analysis of Merton's files Yaqub (2018) also advances four mechanisms for explaining how serendipity unfolds. Importantly, he suggests that these mechanisms may all be evident to different degrees in any one case of serendipity. The first two mechanisms relate to ways of noticing serendipitous events. Thus, "theory-led" serendipitous events are noticed because they are incongruent with theoretical predictions or expectations. Alternatively, "observer-led" serendipitous events are noticed because of a natural variation in individual perceptions and biases. The second two mechanisms are related to ways of organizing that make such events more likely. Thus, "error-borne" serendipity may arise when research is loosely directed to the extent that errors will creep in to experiments that prove to be a source of serendipity. A further processual perspective has been advanced by Balconi and co-authors, (2004), in their suggestion of "network emergent" mechanisms that are founded on the established influence of a researcher's position within a collaborative network.

Scholars have shown interest in the concept of serendipity for many years. In a comprehensive analysis Pek Van Ankel (1992) examined over one thousand examples of serendipity. He argues that it plays a supporting but essential role in discoveries in science, technology, and the arts, and suggests it deserves more serious attention as it may offer unsought benefits in all these fields of endeavour. An equivalent formulation can be seen in the context of entrepreneurship where Fultz and Hmieleski (2021) provide evidence of how serendipity is a key mechanism through which organisational improvisation positively relates to new venture performance. In their study of over 300 new ventures in the US they argue that discoveries occur when looking for something with 'eyes wide open'. This positions serendipity as a practice that relies on intentional observation. That the

observation is unexpected or anomalous and sometimes surprising, is either because it seems inconsistent with prevailing theory or with established facts. Recognising these inconsistencies requires both deep knowledge and curiosity; the curiosity stimulates the investigator to make sense of the occurrence, and deep knowledge allows them to understand what took place. That is, to use their existing knowledge to offer a plausible explanation (Van Andel, 1992). In a detailed analysis of Pasteur's scientific experiments, Vantomme and Crassous (2021) describe how Pasteur was able to make deductions following some unexpected observations because of his unusual education and training. His exceptional experimental abilities also enabled him to imagine interpretations and build new understanding. In their research on theory building Sætre and Van de Ven (2021) argue that serendipity should be viewed as part of the process of scientific discovery. They maintain that within scientific research there will always be unexpected outcomes, but in the absence of a prepared mind the opportunity that serendipity affords is missed (Sætre and Van de Ven, 2021).

In sum, recent decades have witnessed an improved understanding of the nature of serendipity and the generative mechanisms through which it operates. While these theoretical developments have shown that serendipity is not simply good fortune the implications for innovation management in general and NPD remain unclear. In this paper we problematise the enduring notion that the 'prepared mind' is a sure foundation on which to notice and benefit from serendipity. In contrast we argue that cognitive biases render the mind something that cannot be consciously 'prepared' and indeed acts as an obstruction that hinders both the occurrence of serendipitous events and the likelihood of those events being noticed. Rather, we propose a strategy for enabling serendipity and

thereby improving NPD performance by conscious attempts at de-biasing the activities undertaken by NPD teams.

2.1 Research approach to developing a theory of serendipity in NPD

In the first systematic literature review on serendipity in management studies, Balzano (2022) draws attention to the lack of empirical studies of the concept, attributing the difficulty of operationalising 'serendipity' for quantitative research. In this paper we develop a series of propositions that explicate the relationship between cognitive biases and serendipity. Our aim in doing so is to establish a theoretical basis for operationalising the concept of serendipity for future empirical research on NPD, and also to offer practical implications for NPD managers who would like to maximise the potential offered by serendipitous events. Our research approach follows Balzano's recommendation (2022, p143) on the use of *analogical reasoning* (Ketokivi et al., 2017, Cornelissen, 2017) as a basis for developing a theoretical unpinning for our process model and associated propositions.

Conceptual examination of the nature of theoretical arguments in management studies, and the way in which such theories progress, has drawn attention to the "analogical foundations" of management theories (Ketokivi et al., 2017). These authors argue that analogies constitute a key part of theoretical explanations in management studies. Therefore, in the absence of a theory of serendipity in new product development, our approach has been to pursue common analogical foundations with related disciplines, and most notably, science studies (e.g. Yaqub, 2018). Our starting point is to suggest that a theory of serendipity in NPD may be built on a core analogy of "development as unexpected discovery". The premise represented in this analogy is the development of new products is

not always a product of rational design. The novelty of this methodological approach to reasoning allows us to focus of the relevant part of the problem we are addressing (in this case, how to theorise serendipity in NPD and the influence of cognitive biases), without being distracted by the wider phenomenon (in this case, how does NPD routinely unfold). Being conscious of an analogical foundation of "unexpected discovery" prompts us to focus our attention on the possibility of the unexpected, and to suppress consideration of expected outputs of rational design and testing.

3. How Cognitive Bias Prevents Serendipity in NPD

Although extensively explored in cognitive psychology, investigations concerning cognitive biases have only recently attracted attention in new product development (Balzano and Marzi, 2023). Cognitive biases perform essential mental shortcuts that simplify information processing, but this may also serve to inhibit the generation of novelty during NPD as familiar patterns of thinking can produce conventional outcomes or sub-optimal decisions. As one example of this, in an experimental setting it was observed that "Participants converged on worse solutions in environments misaligned with their biases" (Thompson and Griffiths 2021). Despite strong and increasing interest, a literature review by Mohanani et al. (2018) has revealed a scarcity of research and poor theoretical foundations in understanding and interpreting the role of cognitive biases in NPD. Yet within specific technology settings such as non-destructive testing there is recognition of the significant influence of bias on stage-gate performance, for example: "objective assessment is almost impossible, and the (stage-gate) review just manifests predetermined outcomes" (Singh et al., 2021:7).

Recently, cognition research has addressed unconscious cognition including implicit bias, and the literature in this area is “rich, although still fairly small” (Sund, Galavan, and Brusoni 2018). These authors present a framework to guide and position future studies combining cognition and innovation. Their framework combines dual-process theory (Chaiken and Trope, 1999), a model that separates intuitive and reflective cognitive processing (Evans, 2017), or the ‘characters of the story’ that support both slow, reflective thought and fast, intuitive heuristics and biases (Kahneman, 2012). They also separate hot and cold cognition, where cold cognition describes rational and explicit information processing and hot cognition describes emotional decision-making (Hodgkinson et al., 2017; Hodgkinson and Healey, 2011). Emotional decision-making is argued to be of particular relevance for radical innovation, and one account positions “emotion management and self-regulation as core dynamic managerial capabilities essential for meeting the behavioural challenges of radical innovation” (Hodgkinson and Healey, 2014; Solan and Shtub, 2019). Because cognitive bias causes systematic errors in situations of uncertainty (Kahneman & Tversky 1977), it presents multiple barriers to innovation. We illustrate this in our Vignette below with three examples of cognitive bias hindering innovation.

Our analysis of the cognitive biases relevant to NPD applies the cognitive bias categories identified by Mohanani et al. (2018) in their systematic literature review of cognitive biases in software engineering (which involves the design, development, and testing of software applications). We combined this with our own analysis of cognitive biases identified within the new product development literature (see Appendix 1). Table 1 summarises the main biases related to the NPD process, and the risks that they present.

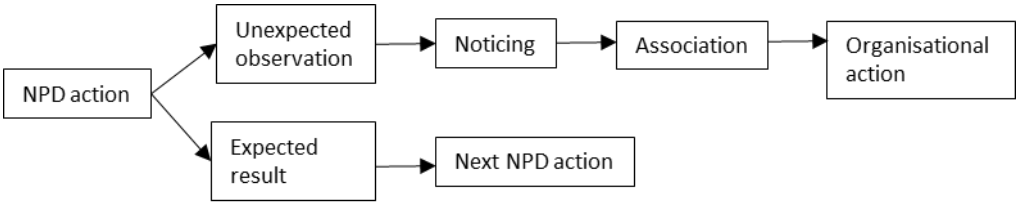
Table 1: Summary of the common cognitive biases recognised within the NPD literature

Common types of cognitive bias	**Influence on new product decision-making process**	**Risks to the NPD tasks**	**Illustrative research**
Action-oriented biases (including overconfidence bias)	Individuals give more weight to information that confirms their existing beliefs. They may downplay or ignore information that contradicts their views. For example, cherry-picking positive focus group comments that support your own beliefs. Individuals overestimate their own knowledge, skills, or ability to predict the success of a new product.	These biases risk a dominant belief that there is nothing new to learn.	Tzabbar, et al., (2023); Gebert et al., (2006); Xia et al., (2023); Feiler, & Tong, (2022).
Stability biases (including anchoring bias)	NPD Teams tend to rely heavily on the first piece of information they receive about a new product, even if that information is arbitrary or inaccurate. This initial "anchor" can shape their subsequent perceptions and evaluations.	These biases risks allocating resource only towards the original concept, rather than emergent avenues.	Shafiei Nikabadi & Aghababayi (2022); Bieske et al., (2023).
Perception biases (including framing effect)	The framing effect refers to the cognitive bias where people react differently to the same information depending on how it is presented or "framed". Framing can be used intentionally to manipulate decision-makers. For example, people are more likely to reject a new product idea when it is framed in a negative way, such as when they are told that the new product will cost more than the old one.	Perception biases risk decisions being made based only on preconceived notions.	(Tversky and Kahneman, 1991); (Schmidt and Zank 2005); (Godefroid et al., 2022); Sameti (2023); Nawaz & Bashir (2022).
Pattern recognition biases (including availability bias and fixation bias)	People often rely on readily available information when making judgments. If they have limited information about a new product, they may use whatever information is easiest to access, which may not be representative or comprehensive. Pattern recognition biases include the Semmelweis reflex, an instinctive rejection of new information that contradicts established beliefs.	These biases risk ignoring new information that contradicts what they know.	Mohanani et al. (2018); Fleischmann et al., 2014; Hendijani (2019); Fabricius & Büttgen (2015).
Interest biases (including confirmation bias)	In a team environment, group members may conform to the dominant viewpoint and avoid dissenting opinions to maintain harmony. This leads to a lack of critical evaluation, resulting in suboptimal decision-making. People also tend to attribute positive outcomes to their own abilities and decisions while attributing negative outcomes to external factors. In the context of new product development, this bias can lead to taking undue credit for successes and deflecting responsibility for failures.	These biases favour the rejection of dissenting views in favour of consensus.	Mueller & Yin (2021); Fridman (2020); Bieske (2023); Wowak (2016); Bharadwaj & Menon (2000).

Consistent with our methodological approach of analogical reasoning (cf. Balzano, 2022, p143) we elaborate these five common types of cognitive bias relevant for NPD in light of the research on how serendipity unfolds in organisations (section 2). Following the discussion in Section 2, Figure 1 presents a processual representation of serendipity during new product development. The starting point is a generic “NPD Action” that a project team

implements, and which could relate to any stage of the NPD process. Where the result is expected, the exact nature of the output is not to be knowable in advance, but the *type* of result is as expected. In this case the project team would evaluate the output and decide upon the next NPD action, and this represents conventional progress in an NPD project. Where the result is unexpected, this represents a potential serendipitous event. Only once the process is complete, that is: the unexpected event is noticed, associated, and organisation action has serendipity taken place. This unfolding process has been proposed in analogous literatures (Busch, 2022; Yaqub 2018).

Figure 1: the process of serendipity in NPD



The challenge of fostering serendipity is often expressed as an oxymoron that appears to defy practical action: “controlled sloppiness” (De Rond, 2014); “intelligent mistakes” (Root-Bernstein, 1988); “loosely directed” (Yaqub, 2018); “happy accidents” Canestrino et al., (2022:1428); and “untidy experiments” (Merton & Barber, 2004). Essentially these oxymorons are describing a central tension in the concept of ‘intelligent mistakes’, which includes taking action with incomplete knowledge (experimentation) and taking a detailed, expert review of accidental errors or unexpected results (learning). This inherently involves trade-offs and conflict between the need to explore, and the need to deliver. The successful management of serendipity requires both the embracing of ‘intelligent mistakes’ to experiment with incomplete knowledge and thus increase the likelihood of unexpected results occurring, but also a careful analysis of what to do after such unexpected results arise. It is often argued that the prepared mind is critical if unexpected results are to be

noticed and their potential explored (Sætre and Van de Ven, 2021). In the following subsections we develop five propositions that explicate how the categories of cognitive biases outlined in Table 1 may hinder the unfolding of serendipity as illustrated in Figure 1.

Action-oriented biases

Action-oriented biases deliberately avoid information in favour of action (Mohanani et al. 2018). The new product development process is highly uncertain (e.g. Antons 2018, Garud 2011) and inherently involves trying to picture the future (e.g. Vértesy 2017). Assessing the range of complexities, which may include relational, regulative, and temporal complexities (Garud 2011), is tricky. However, accurate interpretation of signals is critical for NPD success. In a recent study Feiler and Tong (2022) showed that new product forecasts often under-accounted for the inherent uncertainty. This poses problems for those managing the NPD process because when decision-makers are overly confident, they terminate the search process early (Liedtka 2015), and they may be less receptive to learning from failures or adjusting their strategies. Overconfident decision-makers may persist with unsuccessful product development projects, believing that success is just around the corner. This prevents the allocation of resources to more promising new products, which is key to the 'fail fast' philosophy (e.g. Cooper and Sommer 2016). This overconfidence effect seems to be reduced following large failures which are subject to external criticism, at least in pharmaceutical firms, who appear to make more conservative investments with higher probability of success following a large failure (Stearns 2019).

Vignette: Action-orientated bias

Several examples of overconfidence bias are evident in innovation history, and one of them is the belief that the superiority of typing on the BlackBerry qwerty keyboard would keep

theirs as the preferred smartphone of choice after the iPhone was released, since typing on a flat sheet of glass seemed obviously worse. The very small keyboard with keys that actually depress was an excellent design achievement. At the time few believed Smartphones and their screens would become so much larger leading to fewer touch screen errors and improved performance with touchscreen keypads.

As the Vignette illustrates above it seems this continues to be a problematic issue as a recent study by Xia et al. (2023) illustrates how overconfident CEOs continue to influence strategic innovation decision-making. The foregoing discussion leads to our first proposition.

Several examples of overconfidence bias are evident in innovation history, as seen within the cases of Kodak, Nokia, and Xerox, (see Vignette) all of whom overlooked or downplayed the potential risks from competitors' technology, only to lose out in the NPD race. It seems this continues to be a problematic issue as a recent study by Xia et al. (2023) illustrates how overconfident CEOs continue to influence strategic innovation decision-making. The foregoing discussion leads to our first proposition.

> Proposition 1: If an unexpected result occurs it is less likely to be *noticed* when the NPD actions do not include a deliberate search for new information.

Stability biases

Stability biases are those that make an innovation actor persevere with established or familiar options despite the presence of superior information (Mohanani et al. 2018). This

includes the anchoring bias, which has been observed in project management, whereby an initial estimate of project cost influences all subsequent estimates even when the original is unrealistic (Haugen, 2006). The concept has also been invoked in entrepreneurship studies, where anchoring results in over-estimates of new venture success (Frobes, 2005). This finding is nuanced in more recent research showing that over-estimates require both the semantic and numerical basis of anchoring to be aligned (Barbosa et al., 2019). The concept does not appear to be widely studied in the mainstream NPD literature. A search of the Web of Science database for “Topic = anchoring bias” AND “Topic = NPD” gave a single return: a 2022 PhD thesis examining the use of AI technologies in NPD that was motivated (in part) to overcome “the limitations associated with designers’ bias (i.e., anchoring, curse of knowledge)” (Yuan, 2022).

Vignette: Stability biases (persevere with established or familiar options)

Kodak began making photographic film in the 1930s, achieving an eventual market share of over 80% in the US and 50% globally. At its peak the company had over 130,000 employees, but in 2012 it filed for bankruptcy following a decade of decline in the photographic film industry. A Kodak employee developed the first handheld digital camera in 1975, but their effort to develop digital cameras did not take off until film sales started to decline in 2001. The story of Kodak is an example of how a major company can decide against developing new opportunities because of stability biases, which lead us to ignore and undervalue new information.

However, as suggested in the above illustrations, stability bias is particularly relevant during the earliest stages of the NPD process where initial estimates ‘anchor’ our cost or

performance estimates. The anchoring effect, combined with our need for closure, or "desire for a firm answer to a question and an aversion toward ambiguity" (Kruglanski and Webster 1996, p264) is a particular problem for innovation. This leads to our second proposition.

> Proposition 2: If an unexpected result occurs and is noticed then the likelihood of a novel *association* being made is diminished if the NPD actions do not actively evaluate new information outside the specification of the original NPD concept.

Perception biases

Perception biases in new product development refer to the tendency for individuals or teams to be influenced by their own preconceived notions, beliefs, or expectations when assessing the potential of a new product or idea. This bias can manifest in various ways and can significantly impact the success or failure of a new product. The effect is to prejudice the processing of new information (Mohanani et al. 2018). Perception biases include the 'framing effect', a tendency to give different responses to problems that have surface dissimilarities but are formally identical. Disturbingly Mohanani et al. (2018) found that this can reduce design creativity. Another perception bias is inattentional blindness, as illustrated by the famous 'invisible gorilla' experiment by Simons and Chabris (1999), which showed that subjects given a moderately cognitively demanding task, to count the number of basketball passes by players in white shirts, failed to notice a person in a gorilla suit walk across the court. Their summary of this experiment is that "we perceive and remember only those objects and details that receive focused attention" (Simons and Chabris 1999). This effect has also been called pathological intensity, "a single-minded effort to maximize

output through the narrowing of expertise" (Ramasesh et al. 2014, p198), a problem that can cause errors in NPD. Inattentional blindness can also prevent the detection of new technological opportunities (Wu 2014), slowing down firm reactions to environmental change.

Vignette: Perception bias

The Segway project suffered from inattentional blindness, since they focused their efforts on developing the technology and not seeking customer input. Sales volumes well below Segway's expectations showed that their revolutionary electric personal transport system was not in demand as a mass-market city transport solution. They failed to consider the customer experience in detail, including the need for testing before purchase, charging, the legality of riding it in pedestrian walkways, or parking. Rather, the product was kept secret until launch, and the market response was a surprise to Segway.

The failure to pay attention to obvious signals also indicates that inattentional blindness could result in a failure to notice the subtle signals that are so critical in serendipity. On the basis of this discussion, we formulate the third proposition as follows.

> Proposition 3: If an unexpected result occurs the likelihood of it being *noticed* is diminished when the evaluation criteria of NPD actions are fixed in advance.

Pattern recognition biases

Pattern recognition biases in new product development refer to the tendency to pay more attention to the familiar (Mohanani et al. 2018). This group of biases means that NPD teams rely on familiar patterns or past experiences when identifying opportunities, designing, or evaluating new products. It includes the notion of fixation, which is the tendency to focus

disproportionately on one aspect of a situation, object, or event, particularly self-imposed or imaginary barriers (Fleischmann et al., 2014). Within the context of new product development this includes the notion of loss aversion, which is our preference to make suboptimal or irrational decisions against losses (Schmidt and Zank 2005), or put another way, losses and gains are experienced unequally (Potts 2010). Because loss has a much greater impact on our preferences than gains, we will pay less to gain something than we will accept to lose if we already own it (Tversky and Kahneman 1991). Loss aversion is a fixation bias which also means that we are biased against risk (Tversky and Kahneman 1991). Loss aversion is expected to be particularly acute when multiple uncertainties are faced.

Vignette: Pattern recognition bias

Xerox Corporation was one of the most inventive companies globally. Mainly because of PARC, a research center that developed technologies for the future. Xerox had become the world leader in photocopying. It supplied photocopying machines to all the world's largest organisations. It prided itself on producing the fastest copying machines (hundreds of copies a minute) that were also fitted with outstanding product features that could do such things as: fold, staple, cut, watermark paper and more. This attention to familiar patterns, as a developer of high-speed, high-quality technology leading products, prevented Xerox from recognising the potential threat from a small Japanese producer called Canon. Its machines were small and slow (its machines could copy two pages in one minute), but they were inexpensive. Xerox's focused attention on familiar patterns prevented it from addressing the threat from Canon, now the world's largest producer of copiers.

The accidental discovery of a new technology requires openness to uncertainty, but the decision to pursue a commercial launch when the market is also unknown adds an additional dimension. The Dyson cleaner had a known market (domestic cleaning), but the detailed development of the technology remained a major challenge, and took several years and over 5000 prototypes. The development of the post-it-note included market testing in the 1980s, and the positive responses led to a patent granted in 1993, but it began with the invention of acrylate copolymer microspheres, whose patent was applied for in 1970. The technology was known, but the market uncertainty contributed to the 23-year gap between the patents. The foregoing discussion leads to the fourth proposition.

> Proposition 4: If an unexpected result occurs and is noticed then the likelihood of a novel *association* being made is diminished when the NPD team share similar past experiences.

Interest biases

Interest biases refer to distorted reasoning based on individual preferences and ideas, or sympathy for other people or their arguments (Mohanani et al. 2018). It includes confirmation bias, where individuals overweight evidence in support of currently held views and discount new evidence that undermines current beliefs (Bieske at al 2023). Such behaviour can reduce the novelty of innovation, and this effect is amplified when project goals are clear (Lui et al. 2023). That is, “when goals are clear, team members could be biased against the use of new ideas and practices, and such bias could harm innovation” (Lui et al. 2023, p986).

Vignette: Interest bias

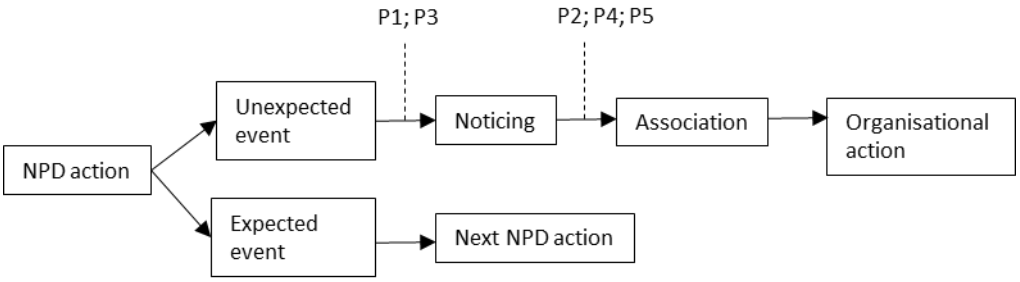
Nokia had a share of over 50% in the mobile phone market. The company was outstanding in developing hardware, which is what made its brand successful in the first place. Nokia believed in its own brand and believed that optimised hardware is what customers desired. For example, it had pioneered increasing the battery life to seven days. Interest bias, overweighting the value of battery life as a currently held view, prevented Nokia from recognising the potential of smartphones. Even though Nokia was one of the first to develop a smartphone back in 1996, they overlooked the market's desire for smartphones.

Confirmation bias is also a barrier to effective problem finding in design thinking, because it constrains abductive reasoning: "individuals naturally gravitate toward information that confirms their preconceived ideas and hypotheses" (Garbuio and Lin 2021). This leads to our fifth proposition.

> Proposition 5: If an unexpected result occurs and is noticed, the likelihood of a novel association being made is reduced when current assumptions about the NPD concept are not challenged.

A summary of the effects of these biases on the serendipity process in NPD is illustrated in Figure 2. This links our five propositions to the key activities within serendipity of "noticing" and "association".

Figure 2: How cognitive bias prevents serendipity in NPD



4 Enhancing Serendipity in NPD through 'Debiasing'

In this paper we adopt a processual approach to theorising how serendipity may be enhanced in NPD through the debiasing of innovation activities. With this processual lens we concur with others (Busch, Yaqub, de Rond) that serendipity should not be associated only with the first stage of that process (i.e. unexpected observations), but that it requires the complete process for serendipity to have occurred (Figure 2).The overarching argument made in this paper is that cognitive biases reduce the occurrence of serendipity by multiple mechanisms, first by hindering chance events, second by hindering their being noticed, and then again by hindering the formation of novel associations. In seeking to *de-bias* these mechanisms (i.e. minimise the hindering effect of cognitive biases), the extant literature has emphasised nurturing individual behaviours to counter the effects of cognitive biases (e.g. Yaqub, 2012; Busch, 2022; Busch and Grimes, 2023). Where these authors theorise the debiasing of individual innovation behaviours, our propositions theorise the de-biasing of the innovation tasks.

Nobel Prize winner Daniel Kahneman noted that in making decisions we systematically violate rationality (Tversky and Kahneman, 1981), but that we still make these errors even when we are fully aware of the cognitive biases causing the irrational decisions (Kahneman

and Tversky, 1977). The practice of "Debiasing" (Fischoff, 1982, Arkes, 1991, Larrick, 2008) is focused on "preventing cognitive biases or mitigating their deleterious effects" (Mohanani et al, 2018, p1319). Most attempts to debias have focused on the individual. Fischoff (1982) argues that this is rarely effective, and that attention should be on debiasing the task. One example of debiasing task effort estimations is the 'Planning Poker' Agile planning technique (e.g. Dingsoyr et al 2016). In this, each development team member independently estimates the task effort, and all members reveal their estimate at the same time, to remove the potential for anchoring or confirmation bias. Recent studies have also shown that training interventions focused on debiasing can be effective in improving decision-making (Morewedge et al 2015). We have developed a number of practical strategies for enabling serendipity (and thereby improving NPD performance) by de-biasing NPD activities, and they are presented in Table 2.

Table 2: De-biasing NPD activities to enhance serendipity

Cognitive bias category	Critical NPD Stages	Relevant cognitive biases	De-biasing activities	Outcome for Serendipity
Action-oriented biases	Product development	Overconfidence bias risks a dominant belief that there is nothing new to learn.	Setting goals for new knowledge acquisition as well as NPD performance.	Enhanced **noticing** of unexpected events.
Stability biases	All stages	The anchoring bias risks any initial estimate influencing all subsequent evaluations.	Actively seek out new information during NPD tasks. Use 'planning poker' for cost, time, or effort estimates.	Enhanced **association** following unexpected events.
Perception biases	Idea generation, Concept testing, Product development	Perception biases risk product evaluations following existing preconceived ideas.	Evaluation criteria should be created during the project, drawing on diverse expertise.	Enhanced **noticing** of unexpected events.
Pattern recognition biases	Product development	Loss aversion bias risks avoiding courses of action that are completely new to the NPD team.	Reframing actions not taken as 'experiments' and agreeing to conduct a defined number of them, thereby keeping open options for NPD actions.	Enhanced **association** following unexpected events.

Interest biases	Idea generation, Concept testing, Product development	Availability bias risks predictions are made using only available information	Deliberately involve partners and team members with deep but distant expertise. Seek out 'surprise'.	Enhanced **association** following unexpected events.

5. Discussion

In this paper, and following Balzano (2022), we have examined the theories and contexts of serendipity across different fields of study in order to mobilise this knowledge in the domain of new product development. In doing so, we argue for adopting a processual view of serendipity and how it unfolds in NPD contexts, rather than fixating on serendipitous events and their likelihood. Having identified a considerable body of literature addressing those factors and activities that can enhance serendipity outcomes (Busch, 2022; Andriani et al., 2017; Andriani and Kaminska, 2021; Wijngaarden et al., 2021; Rauch and Ansari, 2021), we also observed a lack of literature identifying those issues that hinder the occurrence of serendipity within NPD. We provide the first comprehensive assessment of cognitive bias within NPD. Indeed, to the best of our knowledge Table 1 represents a unique analysis of the effect of cognitive biases on NPD, and thus contributes to this stream of research.

5.1 Theoretical implications

Balzano (2022) draws attention to the lack of empirical studies of the concept, attributing this in part to the difficulty of operationalising serendipity in empirical studies. We therefore adopted a methodological approach based upon analogical reasoning (Ketokivi et al., 2017) that supported the development of a series of propositions about the relationship between cognitive biases and serendipity, where serendipity is expressed as a process (Busch, 2022; Yaqub 2018). The propositions relate specifically to the noticing and association process elements, conceptualised by Busch (2022) as individual-level factors. We then propose a number of de-biasing activities to enhance the likelihood and noticing of unexpected events

by de-biasing NPD actions and thereby also increasing the likelihood that serendipity, and in turn the development of radical NPD breakthroughs (Andriani et al., 2017; Andriani and Kaminska, 2021; Wijngaarden et al., 2021). Significantly, most attempts to debias have focused on the individual. Fischoff (1982) argues that this is rarely effective, and that attention should be on debiasing the task. We contribute directly to this theoretical argument by developing five propositions that emphasise debasing of the task to enhance serendipity outcomes.

Our study also addresses an inherent organisation-level conflict in managing for serendipity. Existing literature seems to demand an oxymoron style of management such as: “controlled sloppiness” (De Rond, 2014); “intelligent mistakes” (Root-Bernstein, 1988); “loosely directed” (Yaqub, 2018); and “untidy experiments” (Merton & Barber, 2004). We have argued that managing for serendipity should prioritize preparing NPD actions, rather than preparing the minds of NPD practitioners. Importantly, serendipity is related to opportunity seeking and opportunity recognition (Balzano, 2022) and can emerge from complexity (Garud et al., 2011), uncertainty (Niosi, 1999), and emergent market opportunities (Cha & Bae, 2010). This causes problems for formal project management techniques. The philosophy of rational management underpinning such NPD techniques seems increasingly unsuited to the management of serendipity within NPD (see Trott et al., 2022 for a detailed analysis of stage-gate). This is not to deny the importance of Gate decision-making process. Rather, NPD teams should have a remit to seek out anomalous results, and permission to keep them “alive” through further analysis or experimentation. Such processes might serve to “amplify” weak signals to the point where their potential is noticed. With this line of argument, we are suggesting that for every serendipitous result that has been noticed and documented in case studies, countless more have been missed because the initial signals

were weak, and because cognitive bias prevented them from being noticed and prevented novel associations from being made.

5.2 Implications for firms

The challenge for firms and managers in particular is how to consider cognitive biases when deciding on NPD actions in order to increase the materialisation of serendipity. For example, one could imagine an unexpected finding from a serendipitous event not being noticed (due to confirmation bias or inattentional blindness) or being ignored (due to anchoring bias). Companies need to recognise that they can enable innovation teams to make strategically intelligent mistakes within a clearly understood governance framework. This, in turn, enables a culture that not only tolerates risk but also embraces failure as an integral part of the innovation process (see Baxter et al., 2023). We have argued for NPD managers to embrace the oxymorons inherent in 'intelligent mistakes', which are essentially dilemmas that seem to defy common sense and business acumen.

We have also suggested a number of de-biasing activities (Table 2) that can be used to overcome the effects of cognitive bias in allowing for unexpected events, and in noticing them. Such de- biasing activities can overcome the problem that cognitive bias cannot be removed or avoided even when we are fully aware of the cognitive biases leading to irrational decisions (Kahneman and Tversky, 1977).

5.3 An agenda for future research

What emerges from our paper is a series of propositions that explain how we might enhance serendipity in NPD. Early detection of weak external signals, which is prevented by several categories of cognitive bias, is critical for increasing the likelihood of serendipity. While organizations may scan for weak signals, cognitive bias means many of them are

ignored or dismissed. When an unexpected event occurs, individuals will naturally interpret it in a way that aligns with their preconceived notions or desires, potentially limiting its impact. Thus: Research needs to examine the extent of this phenomenon and further examine what mechanisms can firms put in place to detect and amplify weak signals?

Our Proposition One refers to action-oriented biases that deliberately avoid information in favour of action (Mohanani et al. 2018). Research should examine the extent to which overconfidence bias continues to influence NPD decision-making. How can firms ensure their NPD processes engage in a deliberate search for new information? This could help to increase creativity within NPD processes.

Our research reinforces the processual nature of serendipity and underscores the importance of the "association" activity for serendipity to occur. This raises the question of how flexible are NPD specifications during the NPD process? Our Proposition Three notes it is the evaluation of new information outside the specification of the original NPD concept that can lead to novel associations. Recent cognition research has developed a model of hot and cold cognition, differentiating between rational (cold) and emotional (hot) decision-making (Hodgkinson et al., 2017; Hodgkinson and Healey, 2011). Emotional decision-making is argued to be of particular relevance for radical innovation, and one account positions "emotion management and self-regulation as core dynamic managerial capabilities essential for meeting the behavioural challenges of radical innovation" (Hodgkinson and Healey, 2014). This would seem to be a novel new seam of research worth exploring, particularly in the context of serendipity, where it is not yet a feature of conceptual or empirical work. Thus: What are the necessary management capabilities to meet the behavioural challenges of radical innovation?

Our propositions observe a number of cognitive biases that bias our processing towards supporting existing ideas, and give to familiar areas where we have individual experience. Propositions Four and Five indicate a causal link between team diversity and the likelihood of a novel association being made, as a critical step in realising serendipity. Previous research on creativity (Amabile, 1998) has also revealed that team creativity is enhanced by different perspectives, and so these specific associations between diversity and serendipity should be empirically tested. How can firms ensure the different perspectives within the team are fully considered in NPD decision making?

To finish, it is important to consider how serendipity as field of study, can contribute to the development of a more general management field, as several scholars claim (e.g. (Busch, 2022; Andriani et al., 2017; Andriani and Kaminska, 2021; Wijngaarden et al., 2021). There is a need for specific models for serendipity within NPD and industrial R&D environments. For this reason, we can also briefly propose some general research questions embracing the whole field. One important aspect is that industrial R&D needs to embrace the digital transformation that has deeply affected many other industries. How can companies use digital technologies to capture serendipity and thereby improve their NPD performance? Finally, gender and diversity are recurrent topics in innovation as one of the future trends for the field. While diversity in some industrial R&D environments has changed considerably, some industries such as software development, would benefit from more diversity. Gender diversity has the potential to drive scientific discovery and innovation through the use of diverse teams, research methods, and research questions (Nielsen, Bloch, and Schiebinger 2018). Thus, how can firms incorporate further gender and diversity programmes to specifically enhance serendipity?

5.4 Limitations

The paper has, of course, its limitations. These are inherent in its conceptual nature. The theoretical constructs we propose would benefit from empirical validation to see whether firms can increase the likelihood of serendipity within the NPD process, by focusing on debiasing the task to enhance serendipity outcomes.

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Appendix 1: Common cognitive biases recognised within the NPD literature.

Common types of cognitive bias in NPD	**Influence on new product decision-making process**	**Illustrative research**
Loss aversion / status quo bias	Loss aversion is our preference to make decisions against losses that are suboptimal or irrational. It reduces appetite for risk, which is an essential part of NPD.	(Tversky and Kahneman, 1991); (Schmidt and Zank 2005); (Godefroid et al., 2022)
Fixation and framing bias	The framing effect refers to the cognitive bias where people react differently to the same information depending on how it is presented or "framed". Framing can be used intentionally to manipulate decision-makers.	Mohanani et al. (2018); Fleischmann et al., 2014
Overconfidence bias	Individuals overestimate their own knowledge, skills, or ability to predict the success of a new product, leading them to make decisions that may be wrong, but with high confidence.	Xia et al., (2023); Feiler, & Tong, (2022).
Confirmation bias	Individuals give more weight to information that confirms their existing beliefs. They may downplay or ignore information that contradicts their views. For example, cherry-picking positive focus group comments for a project you believe in.	Tzabbar, et al., (2023); Gebert et al., (2006).
Anchoring bias	People tend to rely heavily on the first piece of information they receive about a new product, even if that information is arbitrary or inaccurate. This initial "anchor" can shape their subsequent perceptions and evaluations.	Shafiei Nikabadi & Aghababayi (2022); Bieske et al., (2023).
Hindsight bias	After a new product succeeds or fails, individuals may develop a distorted view of their earlier perceptions. They may believe that they knew all along that the product would succeed if it does well or that they predicted its failure if it fails.	Sameti (2023); Nawaz & Bashir (2022).
Self-serving bias	People tend to attribute positive outcomes to their own abilities and decisions while attributing negative outcomes to external factors or bad luck. In the context of new product development, this bias can lead to taking undue credit for successes and deflecting responsibility for failures.	Wowak (2016); Bharadwaj & Menon (2000).
Groupthink	In a team environment, group members may conform to the dominant viewpoint and avoid dissenting opinions to maintain harmony. This leads to a lack of critical evaluation, resulting in suboptimal decision-making.	Mueller & Yin (2021); Fridman (2020); Bieske (2023).
Availability bias	People often rely on readily available information when making judgments. If they have limited information about a new product, they may use whatever information is easiest to access, which may not be representative or comprehensive.	Hendijani (2019); Fabricius & Büttgen (2015).
Inattentional blindness	Just as we don’t notice a gorilla when counting basketball passes, an intense focus on a complex goal can blind us to important information.	Ramasesh et al. (2014); Wu (2014)

Biographies

Paul Trott

Paul Trott is Professor of Innovation Management at the University of Portsmouth. He received his Ph.D from Cranfield University in Technology Transfer. His research examines how to improve the performance of firm level innovation. He has published over fifty articles on innovation management in refereed journals including: *Research Policy, R&D Management, Technovation, Public Management Review, Prometheus, International Journal of Innovation Management*. His book Innovation Management & New Product Development is now in its seventh edition. His is also co-author of the Penguin Business dictionary.

Paul Ellwood

Paul Ellwood graduated with a PhD in Chemistry in 1990 from University of Sheffield and a PhD in Management Studies from University of Leeds in 2015. From 1990 to 2006, he worked in the Chemistry-using industries in departments of Research, Manufacturing and Operations, upto the level of Business Director. From 2007 to 2012 he was an innovation management consultant. In 2013 he became Senior Lecturer in Management at the University of Liverpool. His research interests encompass both technology innovation and management education. His university teaching has included Masters (MBA and MSc), Doctoral (DBA and PhD) and Executive Education programmes. He has published in a range of journals including Academy of Management Learning and Education, Research Policy, British Journal of Management and Technovation.

David Baxter

Dr. David Baxter received a PhD in Engineering Design Knowledge Reuse from Cranfield University in 2008. From 2003 to 2008, he was a Research Fellow at Cranfield University. From 2009 to 2014 he served as a Lecturer in Innovation at Cranfield School of Management. Since October 2014, he has been an Associate Professor of Innovation in Southampton Business School, University of Southampton, UK. His research interests include innovation management, knowledge management, and entrepreneurship. He has published articles in journals including Research Policy, European Management Review, Production Planning and Control, and Research Technology Management. Dr. Baxter is also a trustee of RADMA, the Research and Development Management Association.